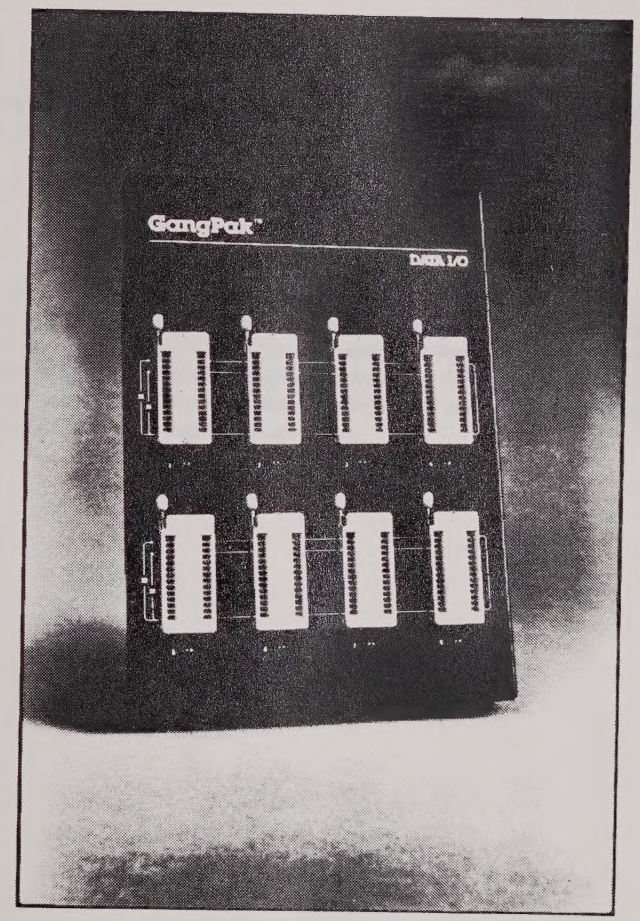
DATA I/O



GangPak™
950-0077-002

JULY 83 REV A **10-950-0077**

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Data I/O reserves the right to make changes to this document without notice at any time.

NOTE

Before using the GangPak™, read section 1.3 for programmer mainframe compatibility information.

In general, if a programming voltage is applied to a device which has been inserted backwards, catastrophic failure will occur. To minimize part loss, GangPak™ uses circuitry and software to test for backwards devices. Devices that are detected are flagged by lit LEDs and error indicators. Due to the electrical characteristics of some parts, backward device testing may damage a percentage of the parts installed backward. Such damage will be identified in further programming operations. Every effort should be made by the operator to ensure that all devices are installed correctly.

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SCHEMATICS

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30-701-1821 Waveform Generator
30-702-1823 Socket Board
30-702-1999 Motherboard

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SECTION 1

INTRODUCTION

1.1 OVERVIEW

Data I/O's GangPak™ reliably programs over 40 industry standard 24- and 28-pin EPROMS and EEPROMs. With "set programming" the GangPak™ can download data from a microprocessor development system and partition it into blocks, with up to eight devices per set. Data for wide-word systems (up to 64 bits) can be interwoven within the downloaded data. The GangPak™ also programs up to eight devices with identical data at one time.

Values for programming variables, including pinouts, voltage levels and timing are stored in the GangPak™ firmware tables. When you choose the family and pinout codes for a particular device, the programmer uses information in these tables to assemble a specialized programming routine in scratch RAM. This method allows high-speed operation with minimum firmware. The GangPak™ is designed to adapt to the programming requirements of future devices with simple software upgrades.

This manual describes the components and operation of the GangPak™. Subjects addressed in this manual and the corresponding sections are listed in Table 1-1. Use this list as a quick reference point of the major sections in this manual.

Throughout this manual, the entries that you are to make from either the programmer or terminal are indicated by the entry enclosed in a key symbol. For example,

indicates the "COPY" key on the programmer keyboard should be pressed. In addition, the symbols shown below are used to indicate modes of operation.

1.2 THEORY OF OPERATION

The GangPak™ can be used in 29A, 100A or System 19 programmers of any configuration; see section 1.3 for the required firmware revision levels. There are two methods of programming available with the GangPak™: gang programming and multi-image programming (word-wide programming or set programming described in sub-section 1.2.3). In both cases, when using a master device or a master set as the data source for programming, you must first instruct the programmer to copy the device data into programmer RAM, then enter the family code and pinout code (as described in subsections 1.2.1 and 3.4). When

Table 1-1. Using the GangPak™ Manual

Subject	Section
Theory of Operation	1.2
Installation procedures for GangPak™	2.0
Basic operation instructions for GangPak™	3.0
Exact key sequences for operating GangPak™ with the 29A Universal Programmer (refer to your programmer manual for System 19 and 100A key sequences)	3.0
Maintenance/Calibration/Troubleshooting	4.0
Circuit descriptions	5.0
Block diagrams	5.0
Schematics	5.0
Family codes and pinout codes	Appendix A
Data I/O service centers	Back of manual
Warranty information	Back of manual

devices with electronic identification are used, the GangPak™ can automatically select the proper family code and pinout code for you (see subsections 1.2. and 3.5 for details).

1.2.1 Software-Controlled Device Selection

Your GangPak™ has been designed to program 24- and 28-pin PROMs in the same 28-pin sockets without adapters, configurators or characterizers. This is made possible through the use of software-controlled hardware. The operator simply enters in a four-digit code (a two-digit family code number and a two-digit pinout code number) and the GangPak™ automatically configures its hardware for that device.

Each device is assigned a family code and a pinout code. Devices and their corresponding family codes and pinout codes can be found in table A-1 in appendix A. The family portion of the code specifies information pertaining to the characteristics and requirements of a device. This includes such things as the programming algorithm type and program pulse width; details on the information specified by the various family codes can be found on the measurement chart in section 4. The pinout portion of the code specifies information on the physical layout of a device such as the location of the address pins and the location of the control pins and their active states; details on the information specified by the various pinouts can be found on the pinout chart in section 4.

1.2.2 Electronic Identification

The GangPak™ can be instructed to automatically configure itself to program PROMs that have been encoded with an electronic identifier by the manufacturer. You can do this by selecting "FF" (family code) and "FF" (pinout code); the programmer will display FF FF. When you do this, the GangPak™ will read the electronic identifier encoded into the device and assemble the correct family code and pinout code. To see what codes were automatically chosen, press

then the programmer will display the codes. This select function will only work after you have initiated a device-related operation (such as a Load operation). If you try to select this function before you have initiated a device-related operation, the programmer will display 0000 **.

When using this feature, be sure that the parts have the manufacturer's electronic identifier and that all the devices program the same way. The GangPak™ will automatically check to make sure that this is done.

1.2.3 Multi-Image Programming

Your GangPak™ can program two to eight PROMs with completely different data patterns, simultaneously. This feature eliminates the need for separate down-load and programming operations, saving time and confusion. There are two ways in which the GangPak™ makes this feature available: selectable modes called set programming and word programming (see section 3.5 for operational information). Both modes take advantage of common data presentation schemes. These modes (set programming and word programming) as well as using these modes together are described in this subsection.

1.2.3.1 Set Programming

It is common for the length of a program to exceed the capacity of a single PROM (as shown in ① of figure 1-1). Capturing these data in a PROM, therefore, requires that the data be partitioned into appropriately sized blocks to be programmed into multiple PROMs as shown in ② on figure 1-1; the size of each block would be determined by the capacity of the PROM being used. Once partitioned, each block of data would then be programmed into an individual PROM as shown in ③ on figure 1-1. The programmed PROMs comprise what is referred to as a "set" since, together, they contain the complete range of data (the original program).

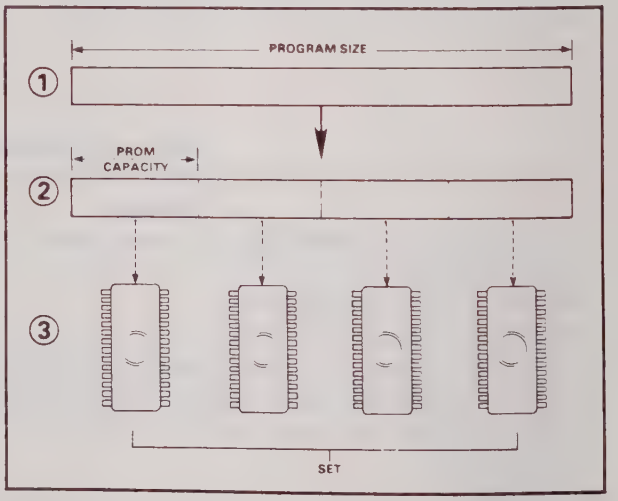


Figure 1-1. Partitioning Data Into PROM-Sized Blocks

The GangPak™ eliminates the need to manually partition these data into blocks and program each partition separately. You simply enter the number of devices in the set and an entire set of PROMs could be created in just one program operation in the time it would otherwise take to program a single device. The number of devices in the set, called set size, can range from one to eight and is selected through the select function (E1, see section 3.5 for details).

For set sizes of less than five, multiple sets of PROMs can be produced simultaneously. The first PROM of the second set is always placed in the next higher socket

number following the last PROM of the preceeding set. To clarify this, refer to figure 1-2 which illustrates set programming for a set size of three. In this example, the first PROM of the set is shown as "A" and last PROM in the set is shown as "C". Notice that the first PROM of the second set, also shown as A, has been inserted in the next socket after C (the last PROM in the preceeding set). Extra sockets forming an incomplete set are to be left unused and are designated as illegal. Thus if you place devices in these sockets during a device operation, it will generate error message A-9 (illegal insertion).

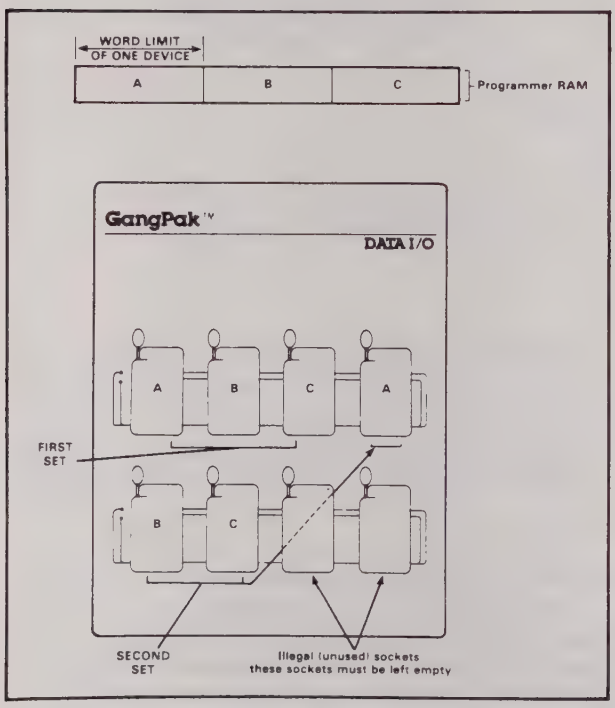


Figure 1-2. Example of Set Programming Operation for Set Size of Three

1.2.3.2 Word Sizes

Most PROMs are organized into 8 bit bytes, each address in the PROM accessing one byte of data. This scheme is fine for byte wide (8 bits per byte) processors. As the need for greater computing power increased, semiconductor manufacturers have introduced microprocessors with wider data bus structures. Today, word wide microprocessor's with data bus widths of 16 and 32 bits are not uncommon. PROMs, however, have continued for the most part to be organized by 8 bits per byte.

One way to use these PROMs in wide word systems is to organize several PROMs in such a manner as to allow each address to access several bytes simultaneously. A group of PROMs organized in this fashion can be considered as one virtual PROM organized into 16 or 32 bit words, each address accessing one word; figure 1-3 illustrates this scheme for a 32-bit wide word system.

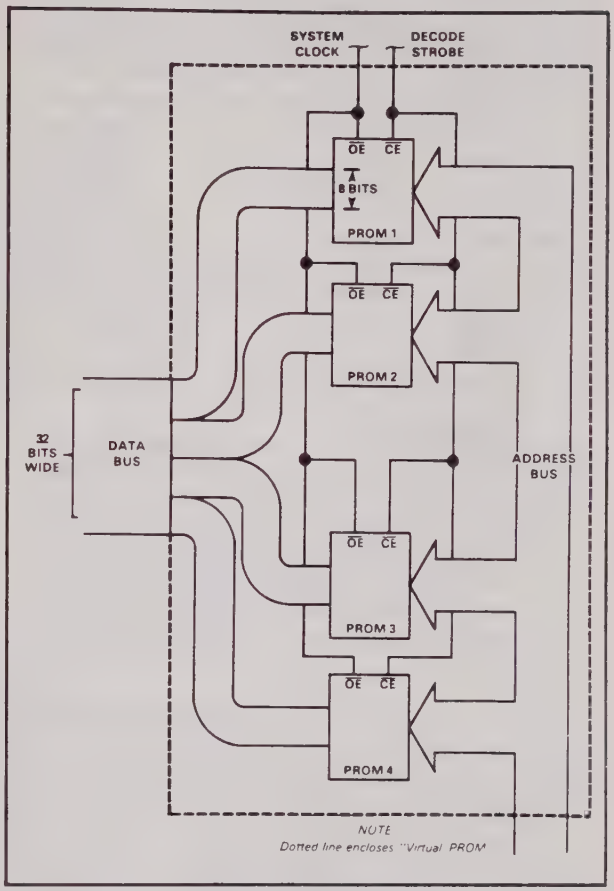


Figure 1-3. 32-Bit Wide Word System

In this scheme, the address and decode of the individual PROMs are wired in parallel — that is, they are shared in common. Each PROM contributes 8 bits to the 32 bit word. Thus, when address Ø is accessed, for instance, PROM 1 would output the high-order byte of the word, PROM 2 would output the upper middle, PROM 3 the lower middle, and PROM 4 would output the low order. PROM 1 could be considered the high-order PROM since it will contain only the high-order portion of the word at all its addresses, and similarly for the other three PROMs.

Data for this scheme would typically be assembled by a development system in the form of consecutive words: each word made up of a high-, upper-middle, lower-middle, and low-order bytes. Data in this format could be downloaded directly to the programmers RAM to be programmed into PROMs by the GangPak™. By selecting the proper word size, the GangPak™ would then automatically distribute the appropriate data to each PROM. Thus, time-consuming, tricky and messy data manipulations are totally unnecessary with your GangPak™ for data arranged in the form of words up to 64 bits wide. These word size selections are accessed through a select code (described in section 3.5).

Figure 1-4 illustrates how the data would be programmed into the PROMs using the GangPak™. As can be seen in this figure, the PROMs in sockets 1 and 5 would contain the byte at BEGIN RAM ADDRESS and every subsequent fourth byte, PROMs 2 and 6 would contain the byte at the BEGIN RAM ADDRESS +1, and every forth byte from there, etc. Thus, in one program operation, two sets of PROMs could be created.

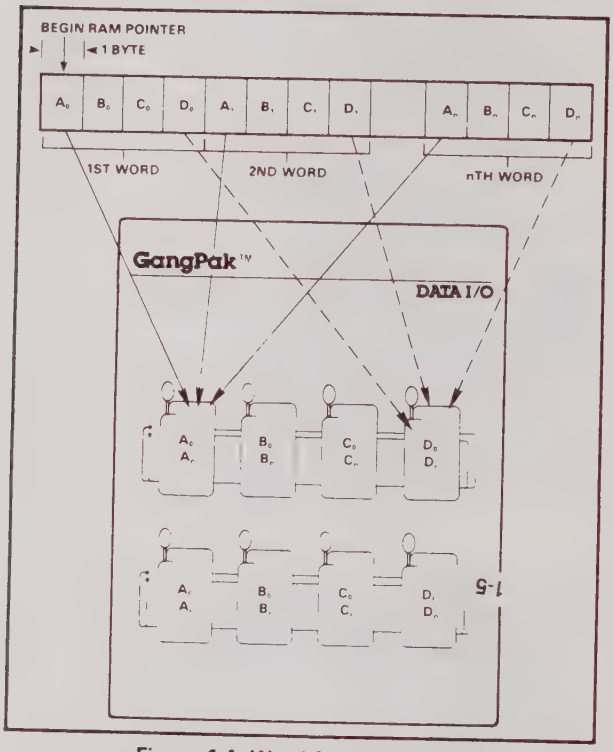


Figure 1-4. Word Programming

1.2.3.3 Set and Word Size Combinations

The GangPak™ also enables you to select set and word size combinations. This mode is useful when one needs to program a large block of data that is arranged by words. For example, if one were to download a file of 16k words, each word being 2 bytes wide, and wanted to program them into a set of 4K x 8 bit PROMs, he would select a set size of 4 and a word size of 16. When selecting set and word size combinations the rule of thumb is: SET SIZE X WORD SIZE ≤ 64. Using this rule of thumb ensures that the GangPak™ has enough sockets to accommodate the operation. Figure 1-5 shows how the GangPak™ will distribute the data.

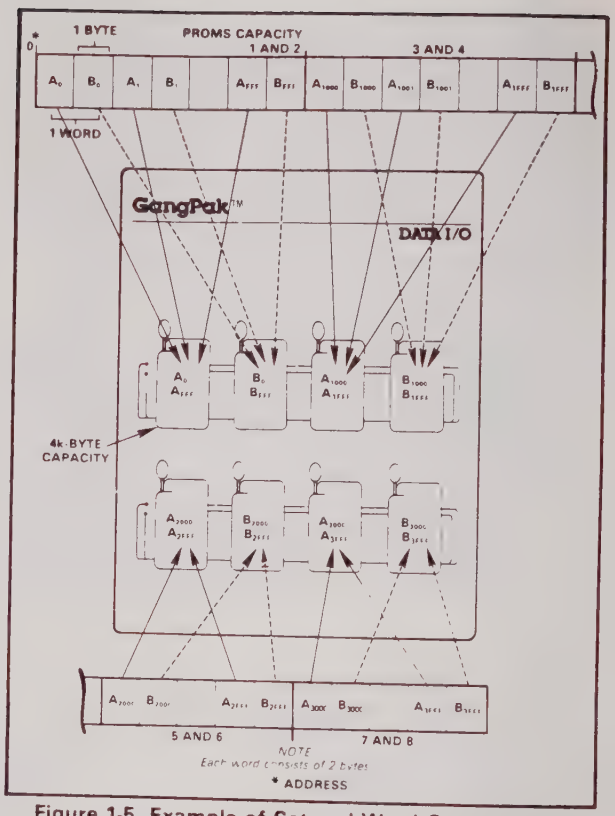


Figure 1-5. Example of Set and Word Combination Programming of 16k Words

1.3 PROGRAMMER COMPATIBILITY

To be compatible with the GangPak™, your programmer may require a hardware and/or firmware update, depending on the model, configuration, and age. The information that follows will help you determine if your programmer requires updating. If you find that your programmer does require updating, contact your nearest Data I/O Service Center.

- System 17 — The System 17 must be converted into a System 19 with the latest firmware installed and latest hardware modifications.
- System 19 — Check to determine if your System 19 contains a 702-1520 or 702-1980 controller board by performing the following steps.

1. Remove the programming pak (section 2.3).
2. Remove the metal shield on the programmer (if any; see figure 2-1).

3. Count the number of EPROM firmware sockets located just behind the pak interface connector. If there are four sockets, it is a 702-1520 board. If there are eight sockets, it is a 702-1980 board.

If your System 19 contains a 702-1520 controller board check the modification status sticker (figure 1-6) on the bottom of the programmer. If the sticker is not there or if only "1" is marked off, your System 19 requires hardware and firmware updating; contact the nearest Data I/O Service Center. If "2" is marked, your System 19 is compatible with the GangPak™.

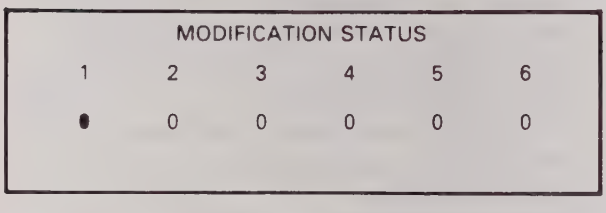


Figure 1-6. Example of A "Modification Status" Sticker

If your System 19 contains a 702-1980 controller board, it may require a firmware update. To display the configuration number of the firmware in your programmer, key in "SELECT-B2-START." If the configuration number displayed is either "3599" or "CC8B", your firmware needs updating.

- 29A Universal Programmer — To be compatible with the GangPak™, the 29A programmers must have Rev C or later firmware. To determine the configuration of the firmware in your 29A, key in "SELECT-B2-START" and observe the display. If the hex number matches one listed in table 1-2, your firmware needs to be updated.

Table 1-2. Programmer Compatibility

Model	Rev	Configuration Number
29A	A B	1ECA 20A4
29A (with computer remote control)	A B	BB41 C00B
100A	A B C D	917F 9405 9DEE 9BED

- 100A Production Programmer — To be compatible with the GangPak™, the 100A programmers must have Rev E or later firmware. To determine the configuration of the firmware in your 100A, key in "SELECT-1Ø" and observe the display. If the hex number display matches one listed in table 1-2, your firmware needs to be updated.

  To fully utilize the set programming feature of the GangPak™, the RAM expansions shown in table 1-3 are available.

1.4 APPLICATIONS

Table A-1 lists all the devices that can be programmed with the GangPak™ at the time this manual was published. In many cases when a new device with industry-standard pinout is introduced within a manufacturer's family, the GangPak™ WILL NOT require a revision to program it. For some new applications, such as to accommodate a new device family, a firmware update of the GangPak™ may be required. The revision number is stamped after the part number (950-0059) along the underside of the top edge of the GangPak™ socket assembly.

Table 1-3. Programmer RAM Expansion Kits

MODEL	STANDARD RAM	MOTHERBOARD	EXPANDED RAM	RAM EXPANSION KIT
29A	8K x 8	1980	16K x 8 64K x 8	951-0100-001
100A	4K x 8	1980	8K x 8 16K x 8	951-0100-002
System 19	4K x 8	1980	8K x 8 16K x 8	951-0100-002 951-0100-001
		1520	8K x 8 16K x 8	950-1533-1 950-1533-2

1.5 SPECIFICATIONS

The GangPak™ receives its power from the programmer mainframe. Programming waveforms are generated from raw programmer supplies using regulators controlled by the programmer's microprocessor. The controlling firmware is located on a circuit card within the GangPak™.

The physical and environmental specifications are:

- Altitude: Sea level to 3 km (10,000 ft)
- Dimensions: 6¾ x 9½ x 4½ inches
- Humidity (operating): 90% maximum (noncondensing)
- Humidity (storage): 95% maximum (noncondensing)
- Temperature (operating): 0 to 40°C (32 to 104°F)
- Temperature (storage): −40 to 55°C (−40 to 131°F)
- Weight: 1.48 kg (3 lb, 4 oz)

1.6 FIELD APPLICATIONS SUPPORT

Data I/O has Field Applications Engineers (FAE's) throughout the world. They can provide additional information about interfacing Data I/O products with other equipment and answer questions about equipment. FAE's are located within the United States at the address listed in the back of this manual. For international applications support, contact your nearest Data I/O representative.

1.7 WARRANTY

Data I/O equipment is warranted against defects in materials and workmanship. The warranty period of 90 days begins when you receive the equipment. The warranty card inside the back cover of this manual explains the length and conditions of the warranty. For warranty service, contact your nearest Data I/O Service Center.

1.8 SERVICE

Data I/O maintains Service Centers throughout the world, each staffed with factory-trained technicians to provide prompt, quality service. In addition to repairs, all Data I/O products can be calibrated at Service Centers. A list of all Data I/O Service Centers is located in the back of this manual.

1.9 ORDERING

To order equipment, contact your Data I/O sales representative. Orders must contain the following information:

- description of the equipment (see the latest Data I/O price list or contact your sales representative for equipment and part numbers),
- quantity of each item ordered,
- shipping and billing address of firm, including ZIP code,
- name of person ordering equipment,
- purchase order number,
- desired method of shipment.

SECTION 2

INSTALLATION

2.1 INSPECTION

The GangPak™ was tested both electrically and mechanically before it was shipped, and was carefully packaged to prevent shipping damage. It should, therefore, arrive free of any defect, without marks or scratches, and in perfect operating conditions. Carefully inspect the instrument for any damage that may have occurred in transit; if you note any damage, file a claim with the carrier and notify Data I/O.

2.2 GANGPAK™ INSTALLATION

The GangPak™ may be installed and removed with the programmer's power on; this feature allows you to retain data in RAM during module changes. If the programmer power is turned on before the GangPak™ is installed, you will hear a "beep" until the GangPak™ is installed.

NOTE

Voltage transients can cause device damage. Be sure that all sockets are empty when:

- *switching power on or off*

or

- *installing or removing the GangPak™*

To install the GangPak™, do the following:

1. Slide the GangPak™ into the opening in the programmer (figure 2-1).

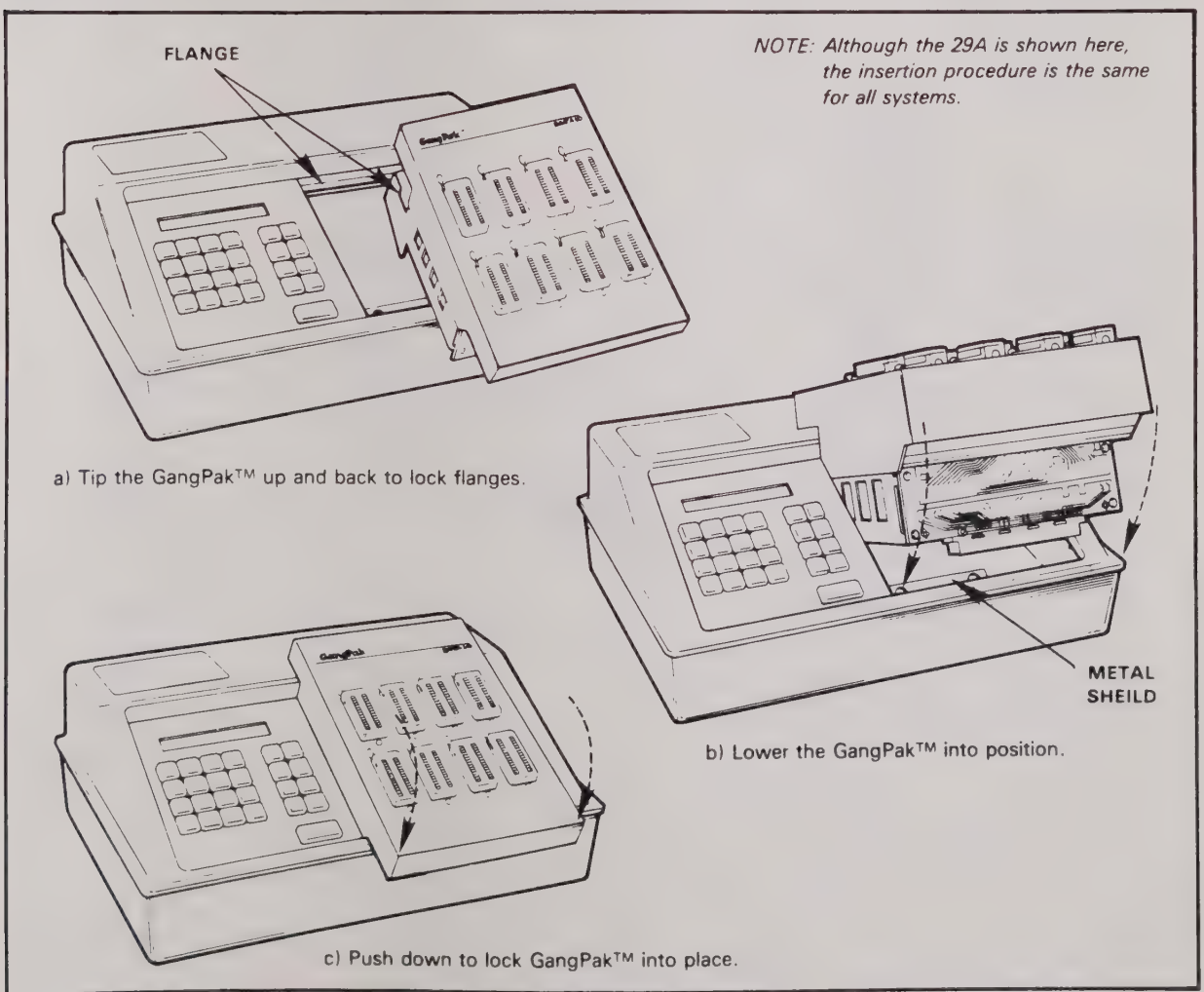

FLANGE
NOTE: Although the 29A is shown here, the insertion procedure is the same for all systems.
a) Tip the GangPak™ up and back to lock flanges.
METAL SHEILD
b) Lower the GangPak™ into position.
c) Push down to lock GangPak™ into place.

Figure 2-I. GangPak™ Installation

2. Tilt the GangPak™ up and gently push it back to hook the flange of the GangPak™ over the back edge of the programmer opening (figure 2-1a).
3. Lower the GangPak™ into position as shown in figure 2-1b.
4. Press gently on the front edge of the GangPak™ to ensure a good connection (figure 2-1c).

2.3 GANGPAK™ REMOVAL

1. Check to make sure the programmer is not in the middle of an operation. If it is, wait until the operation is complete (the action symbol on the display disappears).
2. Check to make sure a device is not in a socket. If one is in a socket, remove it as described in section 3.7.
3. Tilt the GangPak™ up and gently remove it from the programmer.

2.4 REPACKING FOR SHIPMENT

If the GangPak™ is to be shipped to Data I/O for service or repair, attach a tag to it describing the work required and identifying the owner. In correspondence, identify the unit by part number, revision level, and name. If the original shipping container is to be used, place the GangPak™ in the container with the appropriate packing material and seal the container with strong tape. If another container is used, be sure that it is a heavy carton, wrapped with heavy paper or plastic; use appropriate packing material and seal well with strong tape. Mark the container "DELICATE INSTRUMENT" or "FRAGILE."

SECTION 3

OPERATION

3.1 OVERVIEW

The GangPak™ can be used in 29A, 100A or System 19 programmers of any configuration; see section 1.2 for firmware revision levels required. There are three methods of programming available with the GangPak™: gang programming, set programming and word programming.

The typical gang programming operation with a 29A programmer and a GangPak™ is illustrated in figure 3-1. As can be seen from this figure, the GangPak™ can obtain data from three sources (a master device(s), a serial port, or from the keyboard); because the serial port and keyboard operation are unique for each type of programmer, you will be referred to your System 19 or 100A programmer manual for details on how to program using these mainframes.

The procedures to perform basic operations with your GangPak™ and the 29A are described in this section.

Wherever possible key sequences have been included to use your GangPak™ with a 29A Universal Programmer with Rev D firmware (read section 1.3 carefully to determine your programmer's firmware revision level). Refer to your programmer manual for key sequences for the 19 and 100A programmers. The basic operations for the terminal control mode and computer remote control are provided in appendix B.

Throughout this manual, the entries that you are to make from either the programmer or terminal are indicated by the entry enclosed in a key symbol. For example,

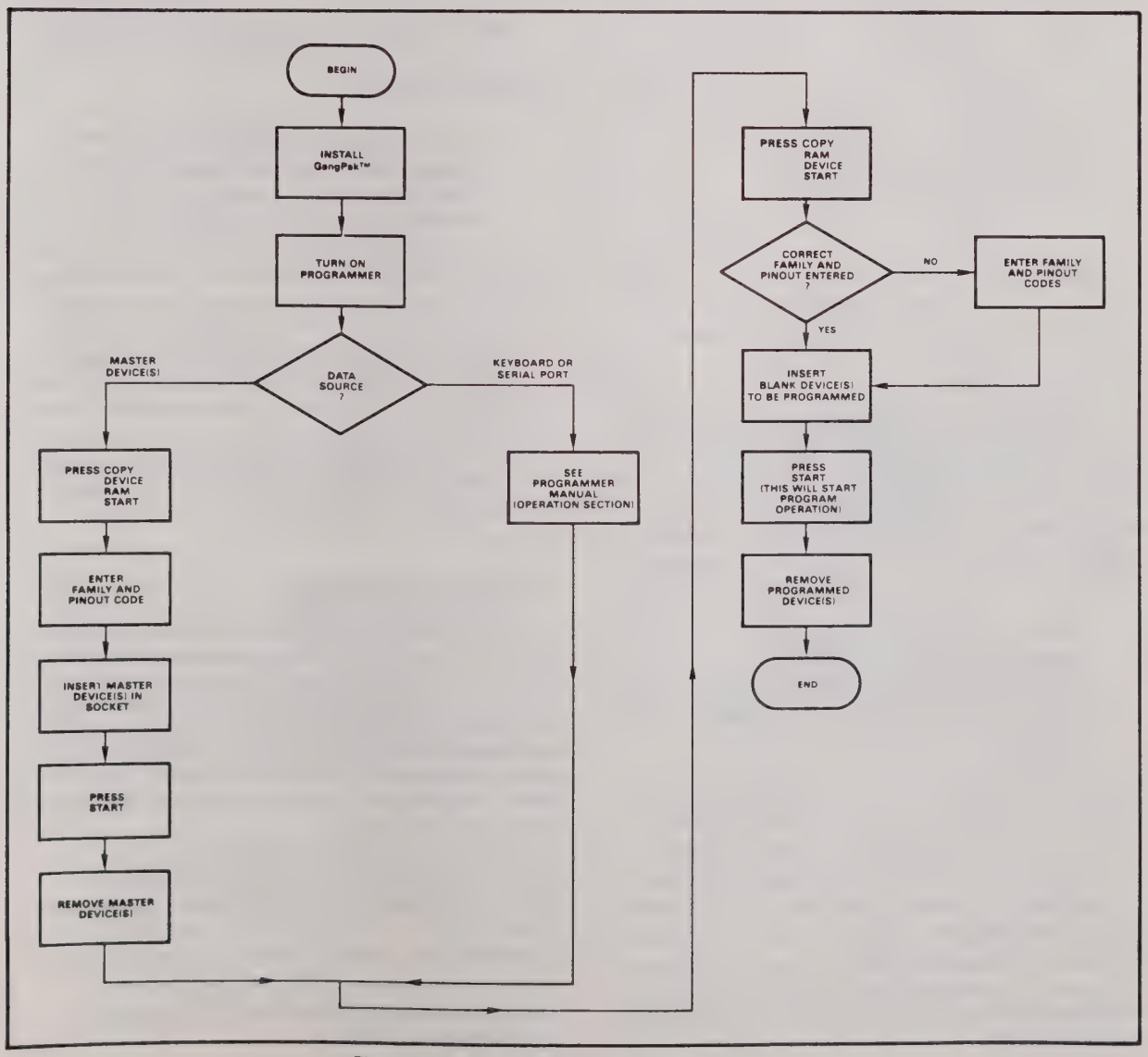
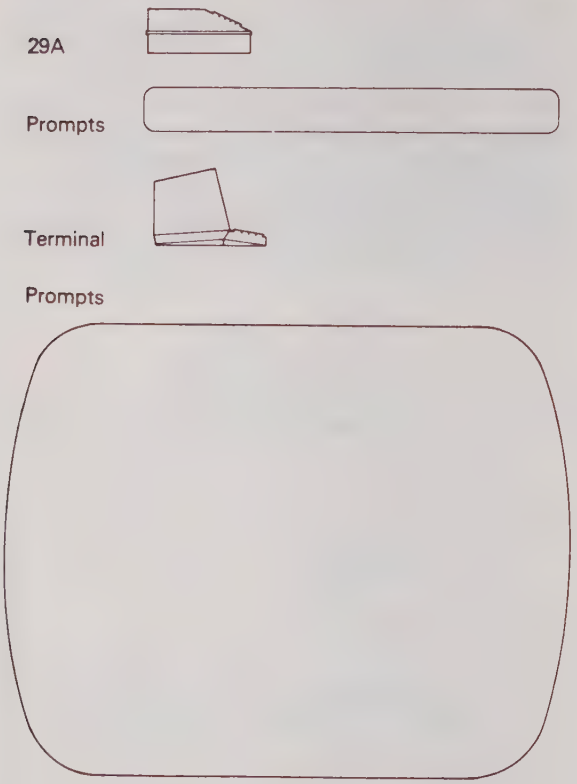


Figure 3-1. Typical 29A Programmer Operation

indicates the "ESCAPE" key on the terminal keyboard should be pressed. In addition, the symbols shown below are used to indicate modes of operation and prompts.



3.2 POWER UP

If the GangPak™ is not installed in the programmer when power is turned on, you will hear a "beep" until the GangPak™ is properly installed.

When power is fully applied, the programmer will perform the self-test routine. When the self-test routine is complete, the programmer will display its ready message.

NOTE

The line in the action Symbol (⊡) rotates 360 degrees several times as the programmer performs the self test. When the self test is complete, the programmer displays

SELF TEST ⊡

SELF TEST--OK

To turn the programmer on:

1. Check to make sure the sockets are empty. If a device is in a socket, lift up the lever (on the upper left of the socket; see subsection 3.4.3) then gently lift the device out of the socket.
2. Plug the AC power cord into a power outlet and on the back of the programmer.
3. Lift the power switch up to the "ON" position; see figure 3-2.

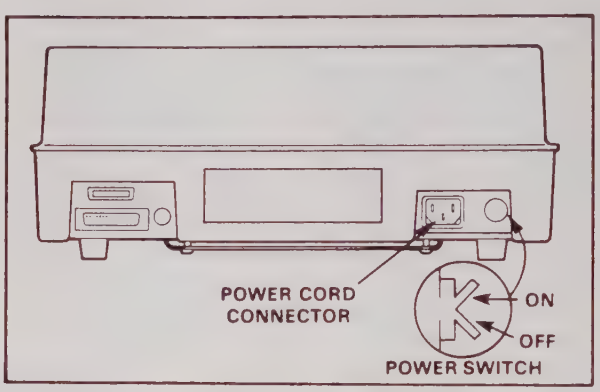


Figure 3-2. Programmer Power Switch Location

3.3 POWER DOWN

CAUTION

Do not turn the power off while the programmer is doing an operation or when a device is in a socket; voltage transients may damage the device.

To turn the programmer power off, do the following procedure:

1. Check the action symbol on the programmer display to make sure that the programmer is not in an operation process. If the action symbol has not stopped, wait until the operation is complete and the action symbol has stopped.
2. Check to make sure the sockets are empty. If a device is in a socket, remove it as described in section 3.4.3.
3. Push the power switch down to the "OFF" position (figure 3-2).

3.4 BASIC OPERATION

The GangPak™ has eight sockets that can be used to program from one to eight devices at the same time. All data transfer or verification operations occur between the programmer's internal RAM and the device(s) or between the RAM and serial port in your programmer. Because the operation procedure to transfer data via a serial port varies among programmers, this manual describes only data transfer using the 29A. For other programmers, refer to the specific operation manual.

The basic data transfer operations that can be accomplished with the GangPak™ and 29A Universal Programmer are listed below and described in the following subsections.

- load RAM with data from a master device or master set (described in section 3.4.4),
- load RAM with data from the serial port (described in your programmer manual),

- program groups of devices with the same RAM data (described in section 3.4.6),
- program sets of devices with RAM data (described in section 3.5.3), and
- verify RAM data against the device data (described in section 3.4.6).

3.4.1 Family Code and Pinout Code Selection

Any device that can be programmed with the GangPak™ is specified by a unique combination of a two-digit family code and a two-digit pinout code; see table A-1, appendix A of this manual to find the correct family code and pinout code for the device you are programming. Once the codes are entered for a particular device, the GangPak™ remains set up for any operation with that device until you enter new codes. If invalid family codes and pinout codes are entered, a beep will sound and the operation will be stopped. In the 29A terminal mode, the programmer will display:

```
COMMAND ERROR 17
```

and the operation will be stopped.

To select the family and pinout codes:

1. Locate the manufacturer and part number stamped on the device.
2. Go to the family and pinout code table (table A-1 in appendix A) and find the manufacturer's name.
3. Go to the column entitled "Device Part Number" and find the number corresponding to the number on the device.
4. Go to the columns labeled "Family Code" and "Pinout Code" to find the code numbers corresponding to the device number for the manufacturer of the device.
5. Enter the family code and pinout code you selected from this table when prompted by the programmer or terminal.

3.4.2 Device Insertion

Once you have entered the appropriate family and pinout codes, the GangPak™ is ready to accept devices.

A good electrical connection between a device and its socket is essential. To ensure a good connection:

1. Check to make sure the programmer is not doing an operation. If it is, wait until the operation is complete.
2. Lift the lever on the upper-left side of the socket; see figure 3-3. (The lever will stay in the upright position.)
3. Gently set the device in the socket.

NOTE:

For 28-pin devices, make sure pin 1 of the device is aligned with pin 1 of the socket (upper left corner); see figure 3-3.

For 24-pin devices, make sure pin 1 of the device is aligned with the dot on the 24-pin line of the socket (see figure 3-3) and pin 12 is aligned with the bottom left corner of the socket.

In general, if a programming voltage is applied to a device which has been inserted backwards, catastrophic failure will occur. To minimize part loss, GangPak™ uses circuitry and software to test for backwards devices. Devices that are detected are flagged by lit LEDs and error indicators. Due to the electrical characteristics of some parts, backward device testing may damage a percentage of the parts installed backward. Such damage will be identified in further programming operations. Every effort should be made by the operator to ensure that all devices are installed correctly.

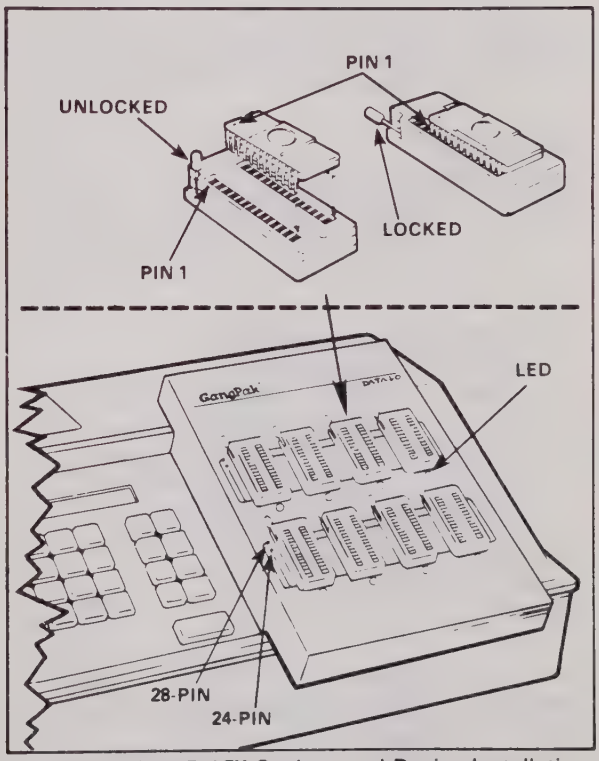


Figure 3-3. GangPak™ Sockets and Device Installation

4. Push the lever down to lock the device in the socket.

3.4.3 Device Removal

To remove a device:

1. Check to make sure the programmer is not doing an operation. If it is, wait until the operation is complete.
2. Lift the lever on the left side of the socket; see figure 3-3. The lever will remain in the upright position.

3.4.4 Load RAM with Master Device Data

To load the 29A RAM with data from a master device with control from programmer front panel, follow the steps given below. A set of master devices of up to eight can be loaded at one time. After the load operation, the set size in effect is automatically set to the number of devices inserted. The set of devices must be installed starting at socket 1 with no gaps of unused sockets between devices in the sets. Data are arranged in RAM in this fashion.

1.

29A Displays

2.

to select the source of the data.

29A Displays

NOTE

ADDR/SIZE pertains to block limit parameters. ADDR is the starting device address. It can be set to any address within the range of the word limit of the device. SIZE is the number of bytes to be considered in the operation and cannot exceed the word limit of one device. If unset, these parameters will default to 0 and the word limit of the device, respectively.

3.

to select the destination for the data.

29A Displays

NOTE

ADDR is the starting RAM address for the operation.

4.

29A Displays

NOTE

The 29A will display 00 if you have not entered a family code and pinout code or will display the last family code and pinout code you entered.

5. Enter the family code and pinout code (see section 3.4.1).
6. Insert a device(s) into the appropriate socket(s).
7.

29A Displays

NOTE

The amount of time the programmer will require to perform this operation will vary depending on the device size. the LED comes on while the device is being loaded and the action symbol line rotates 360 degrees. When the operation is complete, the LED goes off and the action symbol signals the programmer's readiness unless there is an error (see appendix A).

checksum of device data

NOTE

XXXX is the checksum of all the device data. If you have set block limits, the checksum (XXXX) will be calculated only for the device in the first socket. If no devices are detected, the checksum will remain the same as it was before the operation (i.e. the RAM data will be unchanged).

8. Remove the master device from the GangPak™ (see section 3.4.3).

3.4.5 Program Device with RAM Data

When programming a device, the system performs illegal bit tests and blank checks at low V_{CC}.

To program a blank device with the data in the 29A RAM with control from the programmer front panel, follow the steps given below.

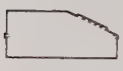
NOTE

If changes are desired for set size and/or word size, make changes as needed before proceeding.

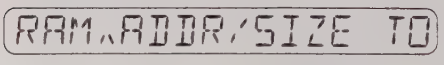
1.

to select the destination for the data.

29A Displays

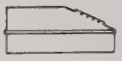
2. 

29A Displays



NOTE

ADDR/SIZE pertains to block limit parameters. ADDR is the starting device address. It can be set to any address within the range of the word limit of the device. SIZE is the number of bytes to be considered in the operation. If unset, these parameters will default to 0 and the word limit of the device, respectively.

3. 

29A Displays

NOTE

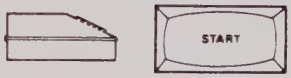
ADDR is the starting device address for the operation.

4.

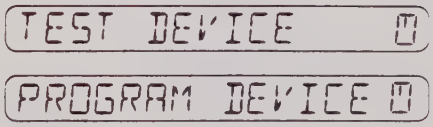
NOTE

The 29A will display 00 if you have not entered a family code and pinout code or will display the last family code and pinout code you entered.

5. Enter the family code and pinout code (see section 3.4.1).
6. Insert a device(s) into the appropriate socket(s).



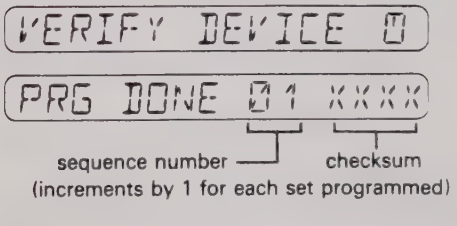
29A Displays



NOTE

During programming, the LED under the devices will be lit.

When programming and verify is complete, the LED under the socket that has failed is lit. If a device has programmed correctly, the corresponding LED will go off.



3.4.6 Verify RAM Data Against Master Device Data

The two-pass verify consists of comparing the device data to RAM data and is performed at two V_{CC} levels; these levels vary according to each manufacturer's requirements.

To verify that data entered in the 29A RAM duplicates the master device data, follow the steps listed below.

1.

29A Displays

2.

29A Displays

3.

29A Displays

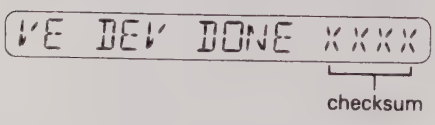
4.

29A Displays

5. Enter the family code and pinout code (see section 3.4.1).
6. Insert the device to be verified into the GangPak™ (see section 3.4.2).

7

29A Displays



NOTE

LEDs will be lit under all sockets that did not verify or had no part detected in them.

8. Remove the master device from the GangPak™ (see section 3.4.3).

3.5 SELECT CODES

In addition to the three basic source-destination functions (copy, verify and edit) and the select functions described in the Operation Section of your programmer manual, the GangPak™ offers six additional select functions (CC, E0, E1, E2, E3 and EF); these functions are not mandatory for basic operation of the GangPak™. These select functions are described in this section.

3.5.1 Examine Family Code and Pinout Code (CC)

Select function CC determines the family code and pinout code of the device(s) in the socket(s).

1.

29A Displays

2.

29A Displays

NOTE

XX is the device family code and YY is the pinout code.

3.5.2 EEPROM Erase Routine (E0)

Select code E0 allows you to erase (return to its unprogrammed state) an electrically erasable PROM (EEPROM). The correct family code and pinout code must have been entered before this select code is executed.

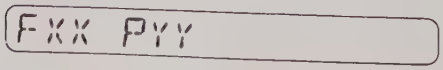
1.

29A Key Sequence

29A Displays

2.

29A Displays



NOTE

Make sure that the family code and pinout code in the programmer display is correct before continuing. If it is correct, do step 3a. If it is not correct, do step 3b.

3a. If the family code and pinout code in the programmer display are correct, insert the PROM(s) to be erased into any socket(s).

or

3b. If the family code and pinout code in the programmer display are not correct, exit the select mode by pressing any function key then enter the correct codes.

3.5.3 Set Programming

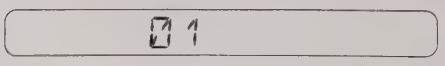
Use this procedure to program a set of devices from RAM data. Verification of correct programming is automatic. For a description of set programming, refer to subsection 3.5.3.

1.

29A Displays

2.

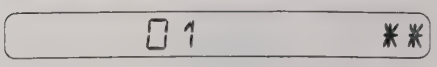
29A Displays



NOTE

At this point, enter set size if required.

29A Displays



NOTE

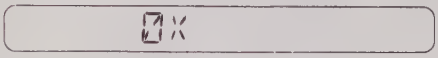
This is the set size. The programmer will default to 01 or the set loaded. To change the defaulted number just select the correct number.

to select the number of parts in a set.

NOTE

X represents the number of parts in a set. This entry can be any number from 1 through 8. If the correct number of parts in the set is displayed, continue with next step. If it is not the correct number, enter in the correct number.

29A Displays



NOTE

01 is the default number.

When entering set size, remember that the number of parts times the device size must be less than or equal to the programmer RAM size. If the set size exceeds the programmer RAM size, the programmer will accept the entry, but will display ERROR 98 when you attempt a device-related operation.

5.

29A Displays

NOTE

XX is the set size now in effect.

If you do a Load operation for a set of devices, the set number will automatically be set at the number of devices in the set.

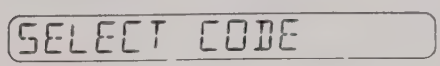
6. Do a Copy operation (see section 3.4.4).

3.5.4 Select Word Size (E2)

This procedure enables you to program PROMs for use in wide word systems (data bus width of greater than 8 bits). To use the word size select function follow the steps below.

1.

29A Displays



2.

29A Displays the current word size.

NOTE
08 is the default word size.

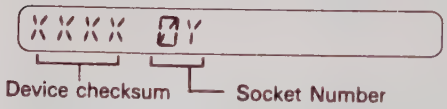
To enter another word size, key in the new number. Possible word sizes are 08, 16, 24, 32, 40, 48, 56, and 64.

3.5.5 Display Checksum of the Desired Device (E3)

29A Displays

29A Displays

29A Displays

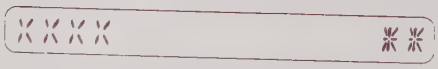


NOTE
ØY is the socket number in which the device whose checksum you are checking is located. The LED of the corresponding socket will light up.

3.5.6 Display Configuration Number (EF)

This command displays the configuration number of the adapter firmware. Configuration numbers are used as serial numbers for firmware.

29A Displays



NOTE
XXXX is the configuration number of the firmware.

SECTION 4

MAINTENANCE/TROUBLESHOOTING/CALIBRATION

4.1 OVERVIEW

The support material in this section has been provided to help you keep your GangPak™ in good operating condition. General maintenance practices are discussed in section 4.2 while the basic troubleshooting steps are listed in section 4.3. For those GangPak™ users who prefer to do their own calibration, detailed procedures including measurement charts and timing diagrams are provided in section 4.4.

4.2 MAINTENANCE

Before the GangPak™ can be cleaned (section 4.2.2) and/or inspected (section 4.2.3), it must be disassembled as described below.

4.2.1 GangPak™ Disassembly

To disassemble the GangPak™, refer to figure 4-1 and the procedures listed below.

1. Remove the GangPak™ from the programmer; see section 2.3 for details.
2. Lay the GangPak™ face down on a flat surface.
3. Unscrew the captive fasteners (figure 4-1a) until they hang loosely; the screws will not separate from their standoffs.
4. Lift the card cage up slightly, then pull it out (as shown in figure 4-1b) to unlock the flanges.
5. Lift the card cage up until you can see the socket board interconnect cable and its connector (figure 4-2).

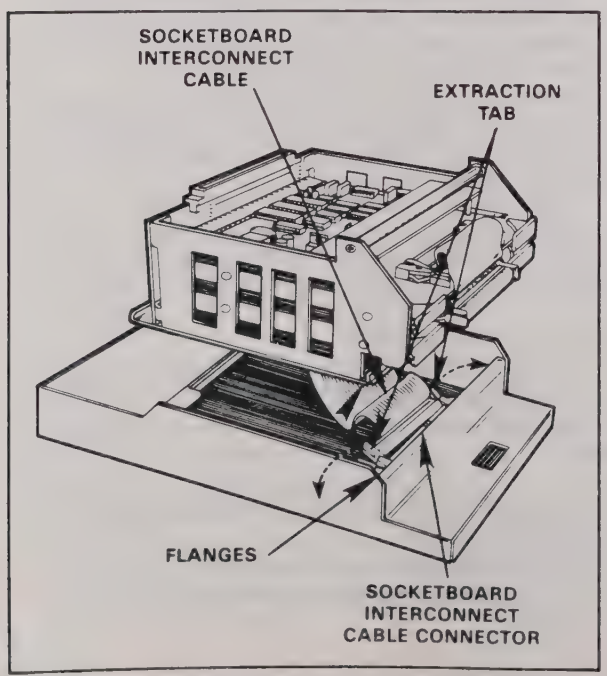


Figure 4-2. Socketboard Interconnect Cable Disconnect

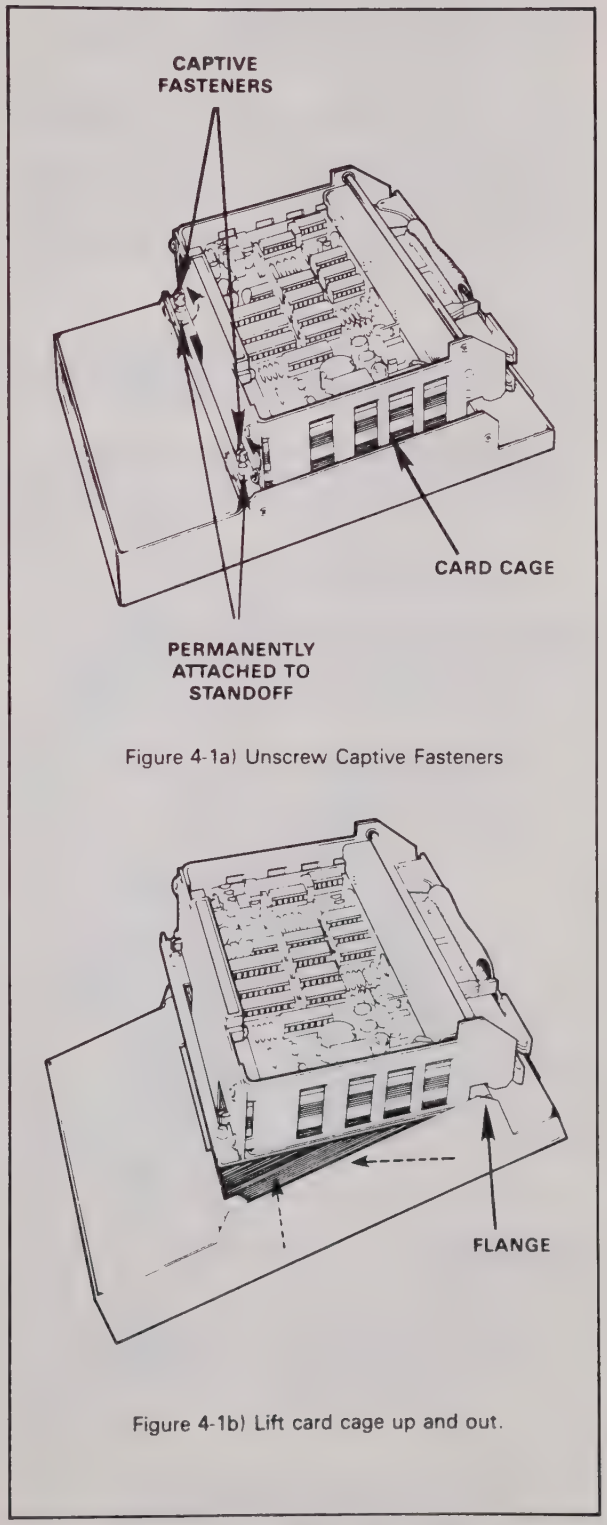


Figure 4-1a) Unscrew Captive Fasteners

Figure 4-1b) Lift card cage up and out.

Figure 4-1. GangPak™ Disassembly

6. Lift the extraction tabs out on each side of the connector (figure 4-2).
7. Pull the cable out of the connector.
8. Lift the extraction tabs out on the top card (waveform generator card) and unplug the interconnect cable from its connector (figure 4-3).
9. Flip the extraction tabs out on the top card (waveform generator card).
10. Pull the waveform generator card out along the guides (figure 4-3).
11. Repeat steps 9, 10, and 11 for the extraction tabs on the digital card.

4.2.2 Cleaning

Inspect the GangPak™ inside and out for accumulated dirt or dust. To clean the GangPak™, follow the procedures below.

1. Wipe any dust and/or dirt off the outside of the GangPak™ with a clean, damp cloth.

NOTE
Do not use abrasive cleaners or solvents which will etch the paint.

2. Remove dust from the circuit boards with a blast of dry, compressed air or a clean, soft-bristled brush.

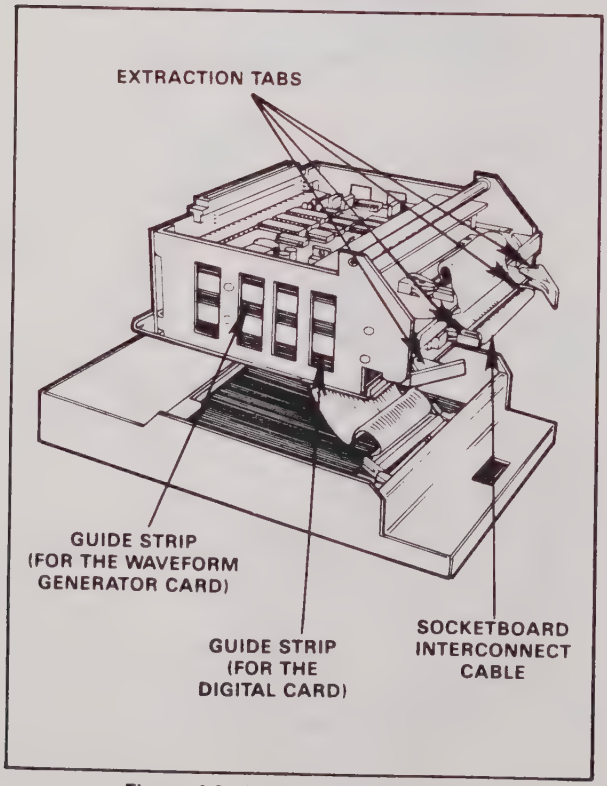

EXTRACTION TABS
GUIDE STRIP (FOR THE WAVEFORM GENERATOR CARD)
GUIDE STRIP (FOR THE DIGITAL CARD)
SOCKETBOARD INTERCONNECT CABLE

Figure 4-3. Circuit Board Removal

4.2.3 Inspection

You can help prevent malfunctions by periodically inspecting your GangPak™. Check cable connections, card seating, mounting of socketed components, etc., for shorts, opens, or unstable continuity.

If you find heat-damaged components, be particularly careful to find and correct the cause of the overheating. This will prevent further damage.

4.2.4 GangPak™ Assembly

1. Push the two extraction tabs down on the digital card.
2. Using the flat surfaces of the extraction tabs, gently push the digital card along the guides into its connector.
3. Make sure the extraction tabs on the interconnect cable connector are open.
4. Firmly, but gently, push the socket board interconnect cable into the connector. Notice that the extraction tabs will move back to their locked positions when the cable is locked into the connector.
5. Repeat steps 3-6 to replace the waveform generator card.
6. Plug the socket board interconnect cable into its connector on the socket board (figure 4-2).
7. Replace the card cage by tilting it up to lock the flanges as shown in figure 4-1, then gently setting it down. Make sure the captive fasteners line up with the fastener holes on the GangPak™ frame.
8. Tighten the captive fasteners finger tight.

4.3 TROUBLESHOOTING

This section is intended to help you interpret and isolate failures in the GangPak™. It should be used in conjunction with section 5 (Circuit Description) and the schematics provided in the back of this manual.

There are three major classes of failures that can occur in a system comprised of a programmer and a GangPak™. The first is no system operation, the second is poor yields, and the third is GangPak™ failure.

After successfully troubleshooting the GangPak™, it must be calibrated according to the instructions in section 4.4. It is very important that the programmer be calibrated before the GangPak™ is calibrated.

4.3.1 No System Operation

The following steps should be performed if the system will not initialize with the GangPak™ installed. After completing each step, determine whether the problem still exists.

1. Check to be sure the GangPak™ is properly installed in your programmer.
2. Check the GangPak™ programmer mating connector (J1) for bent or broken pins. (Pin HH is intentionally shorter.)

3. Check the GangPak™ cards to be sure they are correctly installed in their connectors (section 4.2).
4. Check the ribbon cable to be sure it is properly inserted in the connectors (section 4.2).
5. Check the programmer power supplies for proper voltage output levels (see programmer manual).
6. If steps 1 through 5 fail to isolate the problem, contact your local Data I/O Service Center.

4.3.2 Poor Yields

The following steps should be performed if the yield rate begins to decrease. After completing each step, determine whether the problem still exists.

1. Perform a complete calibration; be sure that the programmer has been calibrated first.
2. Perform waveform observations (section 4.4) for the family of the device being programmed, being careful to note any discrepancies. The Circuit Description (section 5) and the schematics at the end of this manual may be useful in isolating the problem.
3. Perform calibration steps 28 and 29 on the measurement chart for the device family that is giving problems. The Circuit Description (section 5), schematics, and suspected components in tests 1 through 4 of table 4-1 may be helpful in isolating the problem.
4. If steps 1 through 3 fail to isolate the problem, contact your local Data I/O Service Center.

4.3.3 GangPak™ Failure

The following steps should be performed if a device will not program at all or if error messages are displayed on the programmer. After completing each step, determine whether the problem still exists.

1. Check that the family and pinout codes are correct for the device, and that the device is being inserted in the socket correctly.
2. If possible, try a known good device to determine if it is a hardware problem.
3. Check to be sure the GangPak™ is properly installed.
4. Check the GangPak™ programmer mating (J1) connector for bent or broken pins. (Pin HH is intentionally shorter.)
5. Check the GangPak™ cards to be sure they are correctly installed in their connectors (section 4.2).
6. Check to be sure the ribbon cable is correctly oriented and properly inserted in the connectors.
7. Perform a complete calibration noting any measurements falling outside of the indicated limits. Refer to the corresponding test number in table 4-1 for suspected boards and components, as well as the Circuit Description (section 5) and the schematics to help isolate the problem.
8. Perform waveform observations and note any discrepancies. Referring to the Circuit Desription and the schematics may be helpful in isolating the problem.
9. If steps 1 through 8 fail to isolate the problem, contact your local Data I/O Service Center.

4.4 CALIBRATION

The need for calibration varies with how much you use your GangPak™. Generally, we suggest calibration whenever: 1) programming yields fall below the manufacturer's recommended minimums; or 2) when troubleshooting has been completed; or 3) if your company policy requires periodic calibration certification.

NOTE

If calibration or repair is required but you lack the facilities to accomplish it, contact the nearest Data I/O service center.

Because of the different programmer mainframes, this manual does not attempt to cover all areas of programmer calibration. Instead, it lists the steps necessary to calibrate only the GangPak™.

Calibration of the GangPak™ consists of three parts:

1. Power Supply Calibration—measures the DC supply voltages of the programmer. All other voltages depend on these supplies; therfore, this part of the calibration procedure must be done first. Refer to your programmer manual.
2. DC Calibration—consists of measuring and adjusting critical DC voltage levels generated by the GangPak™.
3. Waveform Observation—enables observation of waveforms on an oscilloscope to ensure compliance with the device manufacturers' critical voltage and timing specifications.

The first part of the calibration procedure (power supply calibration) varies with the type of programmer you have. Therefore, this manual refers you to your programmer manual for details on power supply calibration. DC calibration is discussed in section 4.4.1, the optional verify voltage checks are described in 4.4.2, and waveform observation is detailed in section 4.4.3. For information on how to carry out these steps on various programmers, consult your programmer manual.

The following equipment is necessary to calibrate the GangPak™.

- Data I/O Calibration Extender (part number 910-1521)
- Three and a half digit digital voltmeter (DVM)
- Dual-trace Oscilloscope (Tektonrix 465 or equivalent)

Check the appropriate programmer manual for any additional equipment that you may need to calibrate the programmer.

Table 4-1. GangPak™ Troubleshooting Chart

TEST NUMBER	SUSPECT CARDS	SUSPECT COMPONENTS
1	701-1821 701-1822	VR3, R79, Q15, U5, U10, U13, U14, Q9, Q10, T1, U9 U18, U7
2	701-1821 701-1822	VR4, R82, Q15, U16, U5 U18, U7
3	701-1821	VR2, R59, Q15, U5
4	701-1821	U16, U5
5	701-1821	U6, U7, U8, U13, U17, U18, U2, U3, U4, Q2, Q3, Q4
6	-	U16, U5
7	-	U6, U7, U8, U13, U17, U18, U2, U3, U4, Q2, Q3, Q4
8	702-1823 701-1821	U3, U4, U8, U10, U12, U14, U16, U18, U20, U22 U12, U18
9	-	U16, U15
10	701-1821	Q9, Q10, U14, U9
11	701-1821	R58, Q6, U13, U14
12	701-1821	U11, U12, Q13, Q14, Q15
13	701-1821	U9, U11, Q5, U10, Q1
14	-	Q9, Q10, U14, U9
15	-	R58, Q6, U13, U14
16	701-1821	Q1, R56, R30, Q8, R50
17	701-1821	U7, U3, Q3, U17, U18, U13
18	701-1821	U3, Q3
19	701-1821	R16, Q17, R12
20	701-1821	U7, U3, Q3, U17, U18, U13
21	701-1821	R16, Q17, R12, U6, U2, Q2
22	702-1821	U8, U4, Q4
23	701-1821	U4, Q4
24	701-1821	R23, Q18, R19
25	-	U8, U4, Q4
26	701-1821	R23, Q18, R19, U6, U2, Q2
27	701-1821	U6, U2, Q2
28	701-1821	U2, Q2
29	701-1821	R9, Q16, R11
30	-	U2, U6, Q2
31	701-1821	R9, Q16, R11, U8, U4, Q4
32	701-1821	U12, U18
33	701-1823	U3, U4, U8, U10, U12, U14, U16, U18, U20, U22
34	702-1823	U3, U4, U8, U10, U12, U14, U16, U18, U20, U22
35		
36	701-1821	U10, U11, U12
37	702-1823	U1, CR36, CR17

Table 4-1. GangPak™ Troubleshooting Chart (Cont.)

TEST NUMBER	SUSPECT CARD	SUSPECT COMPONENTS
38	702-1823	U1, CR37, CR21
39	702-1823	U1, CR40, CR25
40	702-1823	U1, CR42, CR26
41	702-1823	U1, CR35, CR31
42	702-1823	U1, CR38, CR32
43	702-1823	U1, CR39, CR33
44	702-1823	U1, CR41, CR34
45	701-1821	R8, R73, R74, R27, U19
46	701-1821	VR3, R79, Q15, U5, U10, U13, U14, Q9, Q10, T1, U9
47	701-1821	VR4, R82, Q15, U16, U5, U6, U7, U8, U13, U17, U18, U2, U3, U4, Q2, Q3, Q4
48	701-1821	VR4, R82, Q15, U16, U5, U6, U7, U8, U13, U17, U18, U2, U3, U4, Q2, Q3, Q4

To prepare your GangPak™ for calibration, follow the procedures listed below.

1. Turn the programmer power off; see section 3.3 for details.
2. Remove the GangPak™ from the programmer; see section 2.3 for details.
3. Insert the calibration extender into the programmer the same way you insert the GangPak™ (section 2.2).
4. Unscrew the two thumb screws (captive fasteners) located on the underside of the top cover of the GangPak™ (figure 4-1); they connect the card cage to the socket assembly. Separate the two parts of the assembly.

CAUTION

Do not let the fasteners short to the motherboard.

5. Insert the 64-pin connector of the card cage into the mating connector on the calibration extender (figure 4-4a).
6. Lean the top portion of the GangPak™ against its bottom portion at a 45-degree angle; see figure 4-4.

NOTE

Be sure the socket assembly flange locks into the card cage flange (see figure 4-4b).

Be careful not to strain the cable or scratch the top of the programmer.

4.4.1 DC Calibration

The DC calibration procedures described in this section enable you to adjust critical DC voltage levels generated by the GangPak™. To follow these procedures, see the measurement chart at the end of this section. This measurement chart contains the information necessary for all DC calibration tests. This information is included on the measurement chart (located at the end of section 4) in columns with the following headings:

- Step No.—tells which step to use for each test. Step numbers are set at the programmer keyboard and reflected in the display.
- Test No.—identifies individual tests.
- Test Description—identifies the functions being tested.
- Measurement Test Location—tells which socket pins, circuit boards, or test points to probe for measuring voltages.
- Measurement—specifies allowable measurement ranges. If a reading falls outside the range and you cannot adjust it to within the range, do not use the GangPak™ until the problem is corrected.
- Adjustment Location—tells which potentiometer to adjust if a measurement is out of range.
- Comments—gives special instructions for particular tests.

The DC calibration procedures are as follows:

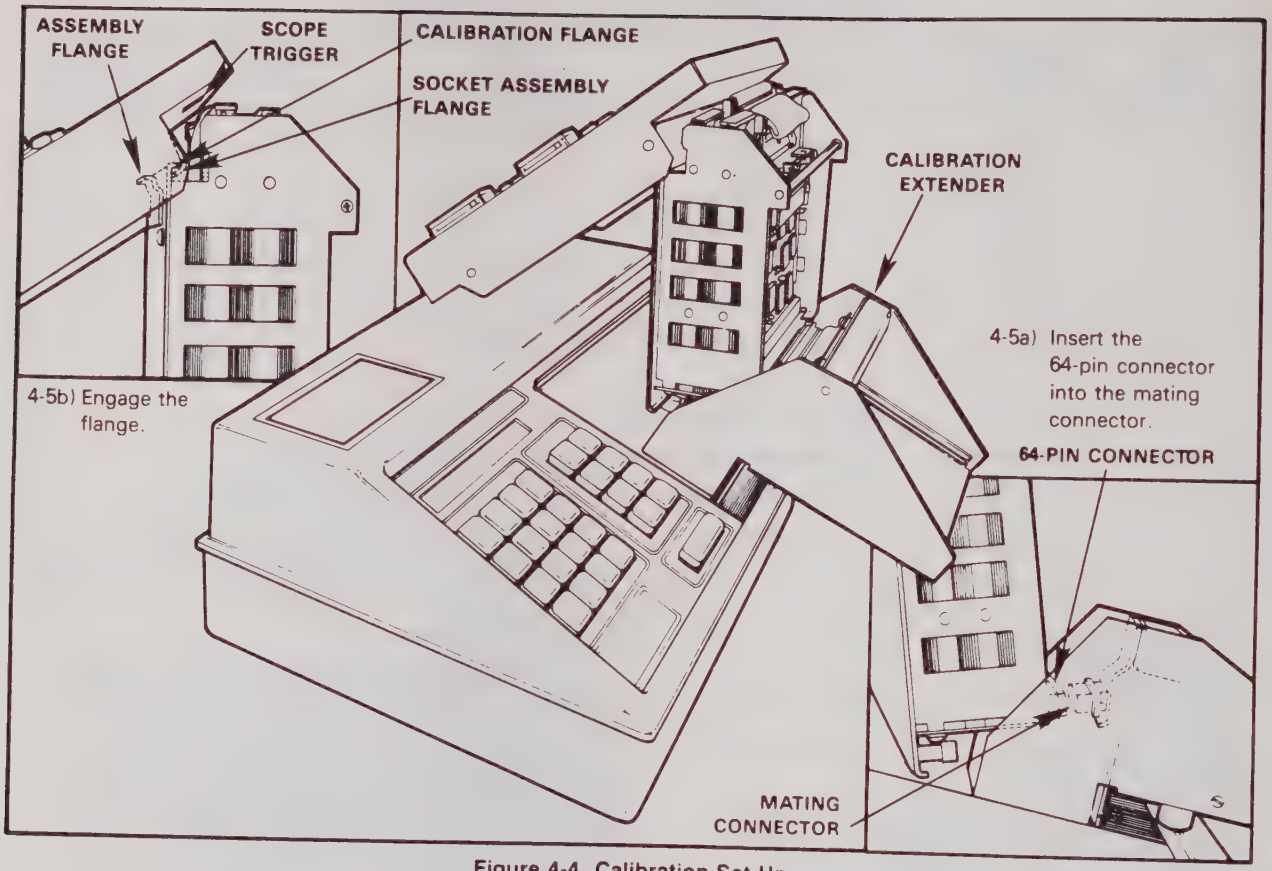


Figure 4-4. Calibration Set-Up

CAUTION

Remove all devices from the sockets before entering the calibration mode (see section 3.8 for details). Waveform generation may damage any device in the GangPak™ sockets.

1. Turn the programmer power on (section 3.2).
2. Put the programmer into the calibration mode by following the key sequences in table 4-2.
3. Perform the general calibration steps (step 27) on the measurement chart. For steps 26 and 27, refer to the figures at the end of the measurement chart to observe the "V_{CC} sawtooth" "V_{PP} sawtooth," and the switching pin drivers.

Table 4-2. Key Sequence to Access the Calibration Mode

Programmer System	Key Sequence to Enter Calibration Mode	Increment Step No.	Decrement Step No.
19	Press SELECT Press C2 Press ENTER Enter Step Number (a) Press START	Enter	Review
29A	Press SELECT Press C1 Press START Enter Step Number (a) Press START	Start	Review
100A	Press SELECT Press 12 Enter Step Number (a) Press START	Start	Back-space

(a) Optional

For each general calibration step on the measurement chart do the following:

- Take measurement readings at the device sockets or test points indicated in the measurement chart; figure 4-5 shows the pin numbers for the sockets and figure 4-6 shows the test points.
- Ground the digital voltmeter to pin 14 of any socket on the front panel of GangPak™.
- The adjustment pots on the waveform generator enable you to make adjustments when your measurements do not match the measurement chart; figure 4-6 shows the location of these adjustment points.
- Access each new step by pressing the START (or ENTER) key. The new step number will appear on the display when the GangPak™ is ready for the next step. To go back to a previous test, press the REVIEW (or BACKSPACE) key.

NOTE

The remaining calibration (steps 28-33) are family-specific and can be performed optionally.

4. For each family-specific calibration step on the measurement chart, do the following to enter the family codes and pinout codes.
   - Enter the family code and pinout code when prompted by the programmer; refer to your programmer manaul for further information.

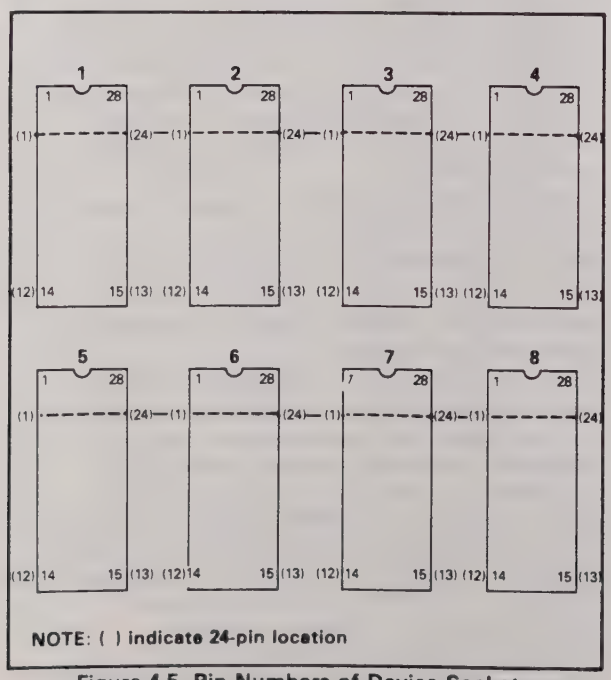


Figure 4-5. Pin Numbers of Device Sockets

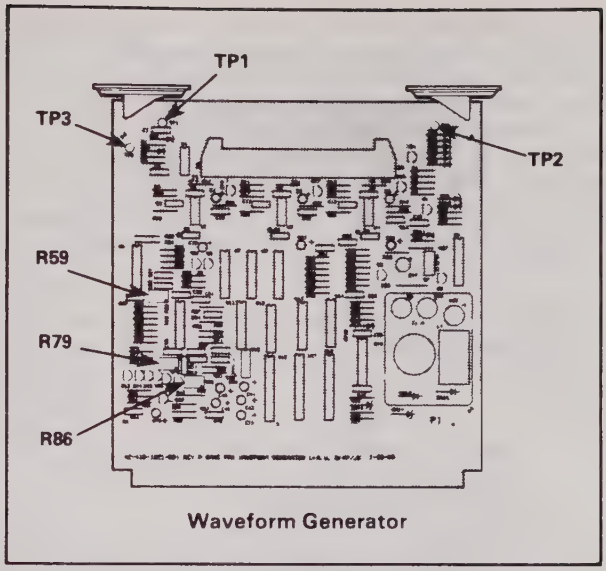


Figure 4-6. Adjustment Locations

- Put the programmer back into the calibration mode; see table 4-2 for the key sequence.
- Enter the step number from the measurement chart.
- Press START.

4.4.2 Optional Verify-Voltage Checks

Two calibration steps (28 and 29) have been provided for the measurement of first and second pass verify voltages. The family characteristics table in the applicable family timing diagram defines the levels for first and second pass verifications for each family. These are provided for the investigation of yield problems; no adjustments are available. Under normal circumstances, these steps can be eliminated from a routine calibration.

4.4.3 Waveform Observation

Programming waveforms of your GangPak™ can be observed with an oscilloscope and compared to the timing diagrams that have been provided at the end of this section. In this way, timing and magnitude relationships can be measured against known specifications to confirm that the GangPak™ is performing to the device manufacturer's specifications. Since the GangPak™ generates a large number of waveforms and all calibration adjustments are accomplished in DC calibration, it is only necessary to observe waveforms for commonly used devices or those that are presenting yield problems.

During the waveform observation phase of the calibration procedure, your GangPak™ uses a firmware routine that generates programming waveforms for the data stored in system RAM. An oscilloscope trigger pulse is generated for every address increment. This occurs after the reject pulse count has been reached for all the bits being programmed in the previous data word. The address is

automatically reset to Ø when the maximum PROM address is reached, and incrementing continues. Waveform observation can be done with the GangPak™ either on the calibration extender or plugged into the programmer.

When used with a timing diagram, this procedure allows you to compare waveforms on the oscilloscope with the waveform photographs on the timing diagram for any type of device; a detailed explanation of the timing diagrams is provided in section 4.4.4. The waveform observation procedure is as follows:

1. Refer to table A-1 to determine the family codes and pinout codes, polarity, and technology of the selected device.

NOTE

Polarity is indicated in the Family code. Odd numbered families are VOL and even numbered families are VOH.

2. Initiate a load operation; refer to section 3.4 for details.
3. Key in family codes and pinout codes when prompted by the programmer; see section 3.4.

CAUTION

Remove all devices before entering the calibration mode. Waveform generation may damage any device in the GangPak™ sockets.

5. Enter the waveform generation mode by following the key sequences listed in table 4-2.
6. Enter the programmer erase waveforms at step 33 of the measurement chart by following the key sequences listed in table 4-2.
7. Trigger your oscilloscope by connecting to the test point under the top edge of the socket assembly (see figure 4-7).
8. Ground the scope to pin 14 if a socket is illuminated.
9. To observe individual waveforms, refer to figure 4-8 under the pinout code number entered in step 3. The individual socket illustrations give the numbers of the socket contacts to probe when observing the waveforms on the timing diagram.

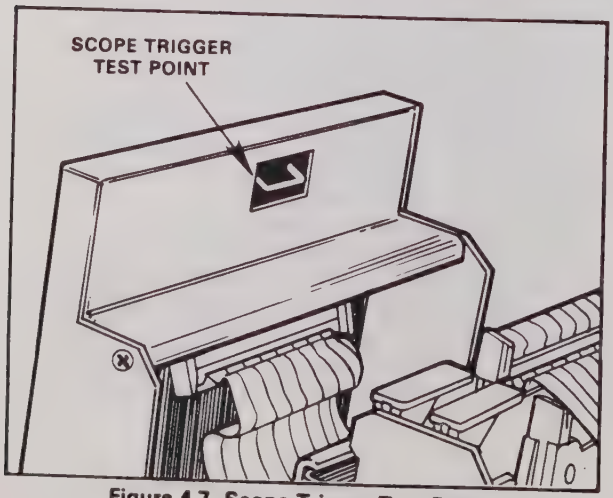


Figure 4-7. Scope Trigger Test Point

NOTE

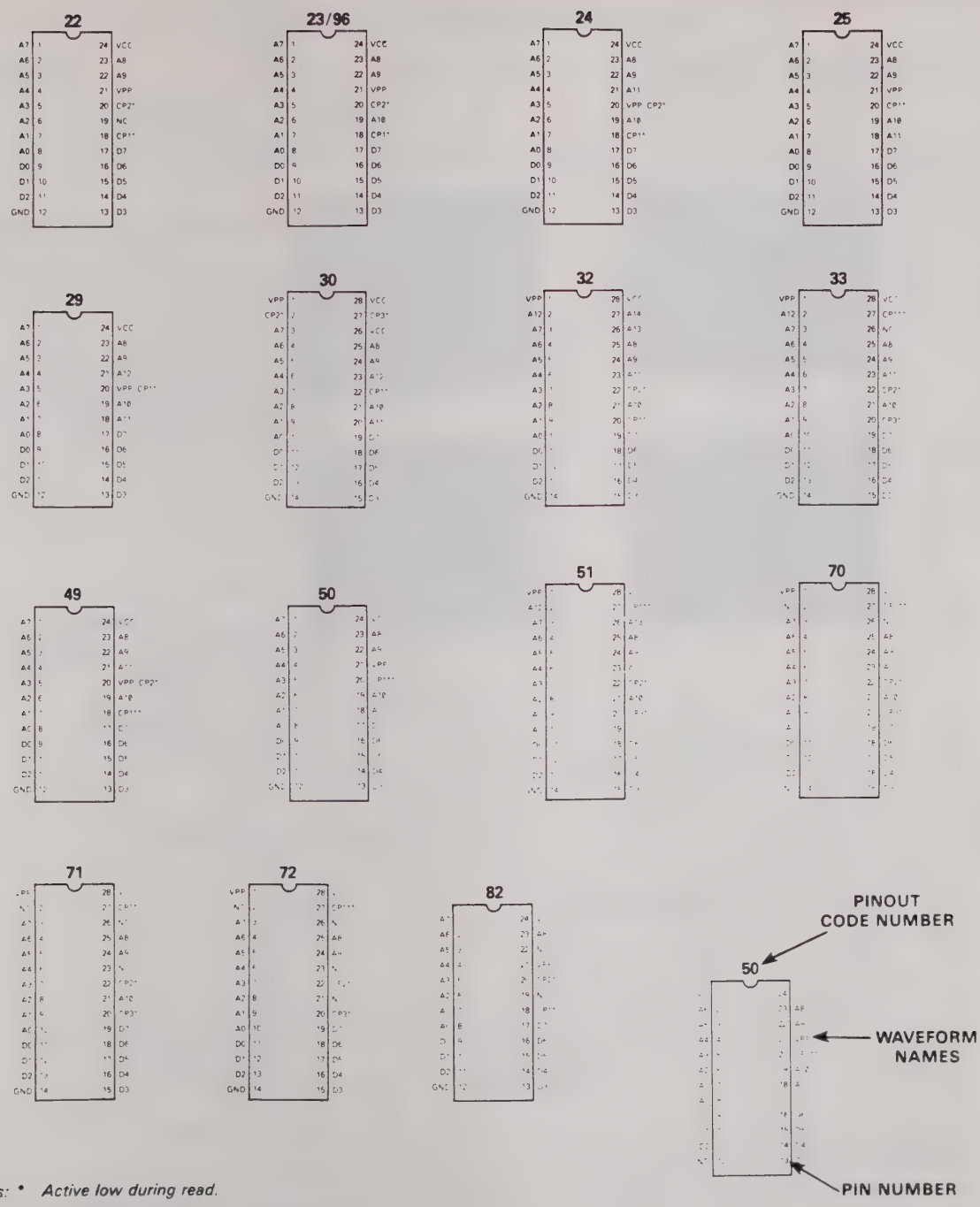
Considerations helpful in setting up and interpreting the waveform displays are explained in section 4.4.4.

4.4.4 Detailed Explanation of the Timing Diagrams

This manual contains a timing diagram for each device family that can be programmed by the GangPak™. Each timing diagram contains a set of waveform photographs that show critical programming parameters. To use these diagrams and photographs, read the information provided below and refer to the sample timing diagram (figure 4-9).

V_{PP} t_r and t_f photographs were taken with the volts-per-division uncalibrated. This was done to illustrate the t_r and t_f "10-90%" points more clearly. This is indicated by the symbol preceding the "Voltage" displayed on the waveform photograph.

1. FAMILY CODE NUMBER—corresponds to the family code number of the device (refer to table A-1).
2. FAMILY CHARACTERISTIC TABLE—lists the minimum and maximum parameter values; voltage and timing parameters other than those listed in this table are to be considered non-critical with a ±10% tolerance.
3. NOTES—Important information pertaining to a timing diagram.
4. WAVEFORM NAMES—correspond to the pin names on the pinout chart (figure 4-8); the pinout chart tells you which socket pins to probe when you are observing the waveforms for a particular device pinout within a family. (The pinout is indicated by the number above each socket on figure 4-8 which corresponds to the pinout code on table A-1.)
5. LAYOUT SEQUENCE NUMBER—used as a reference point within each diagram.
6. DELAY TIME POSITION—indicates the time from the start of the main sweep to the start of the delay time.
7. OSCILLOSCOPE GROUND REFERENCE—identifies the ground level on a waveform.
8. TIME-BASE AND VOLTS-PER-DIVISION SETTINGS—horizontal positioning of the waveforms is not critical and may vary slightly from the photographs. The important observation is the timing relationship between the waveforms in the photographs. You can adjust this timing relationship on your oscilloscope to set convenient reference points. By taking into account any time-base variance, you can also make time comparisons between photographs. The time base is always the same for different waveforms in the same photograph.
9. VOLTAGE—indicates volts per division. The one in the upper left corner is for the top trace and the one in the lower left corner is for the bottom trace.



Notes: • *Active low during read.*

•• *Clocked during read for address latches.*

Figure 4-8. Pin Names by Pinout Code Numbers

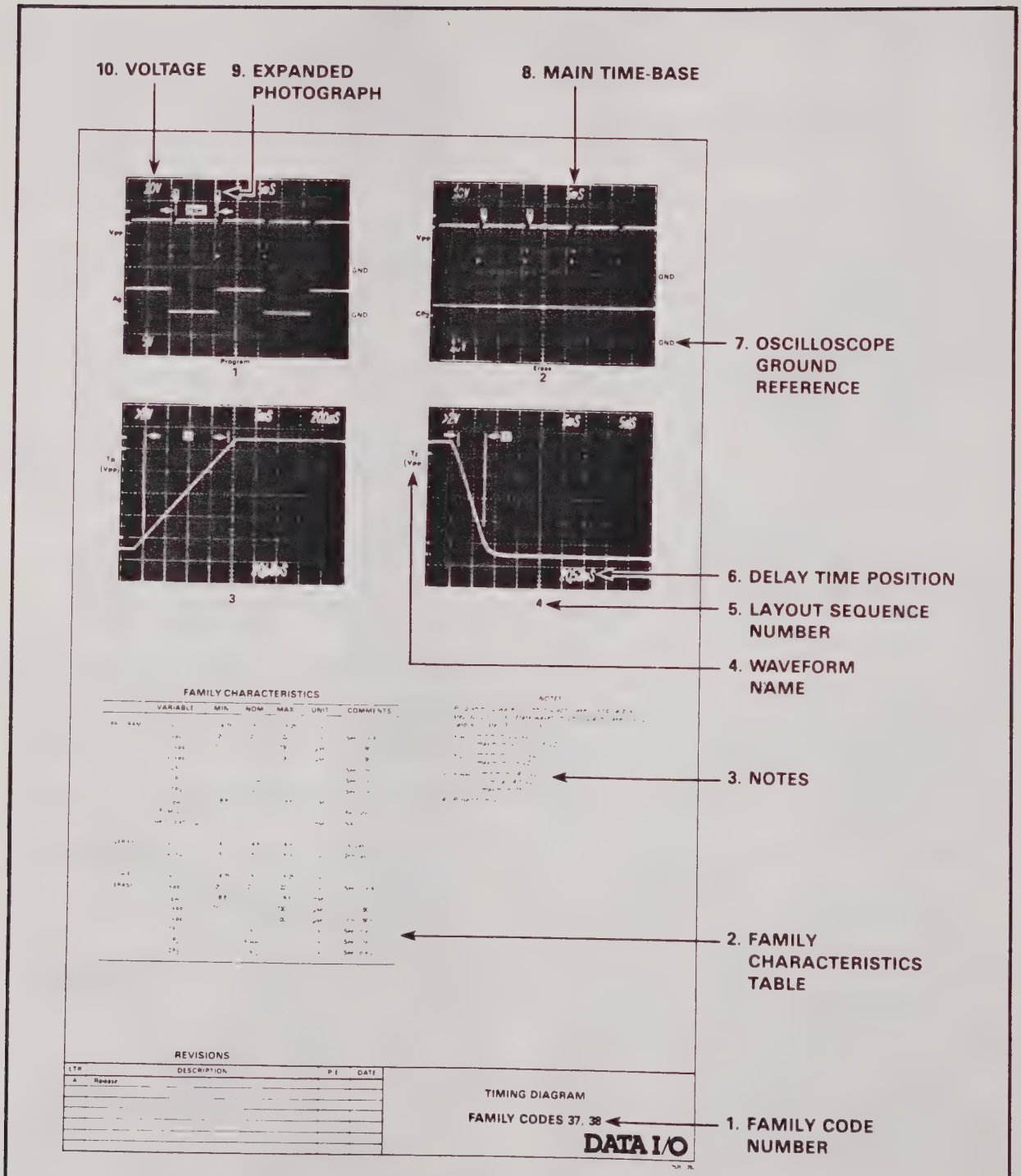


Figure 4-9. Sample Timing Diagram

SECTION 5

CIRCUIT DESCRIPTION

5.1 OVERVIEW

This section defines the functions of the GangPak™'s principal hardware components. Each circuit card assembly is depicted by a block diagram accompanied by a written description.

5.2 GENERAL ARCHITECTURE/ COMPONENT LAYOUT

The GangPak™ is controlled by the programmer's extended processor bus through the mating connector (J1 on Figure 5-1). The control software for the GangPak™ is located in EPROM on the digital card (701-1822).

The principal components of the GangPak™ are the motherboard, the waveform card, the digital card, and the socket card. The component layout of the GangPak™ is shown in figure 5-2 and described in the following subsections.

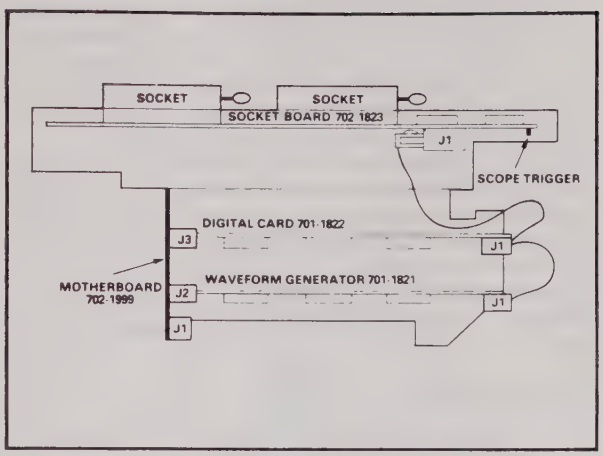


Figure 5-1. Principal Components

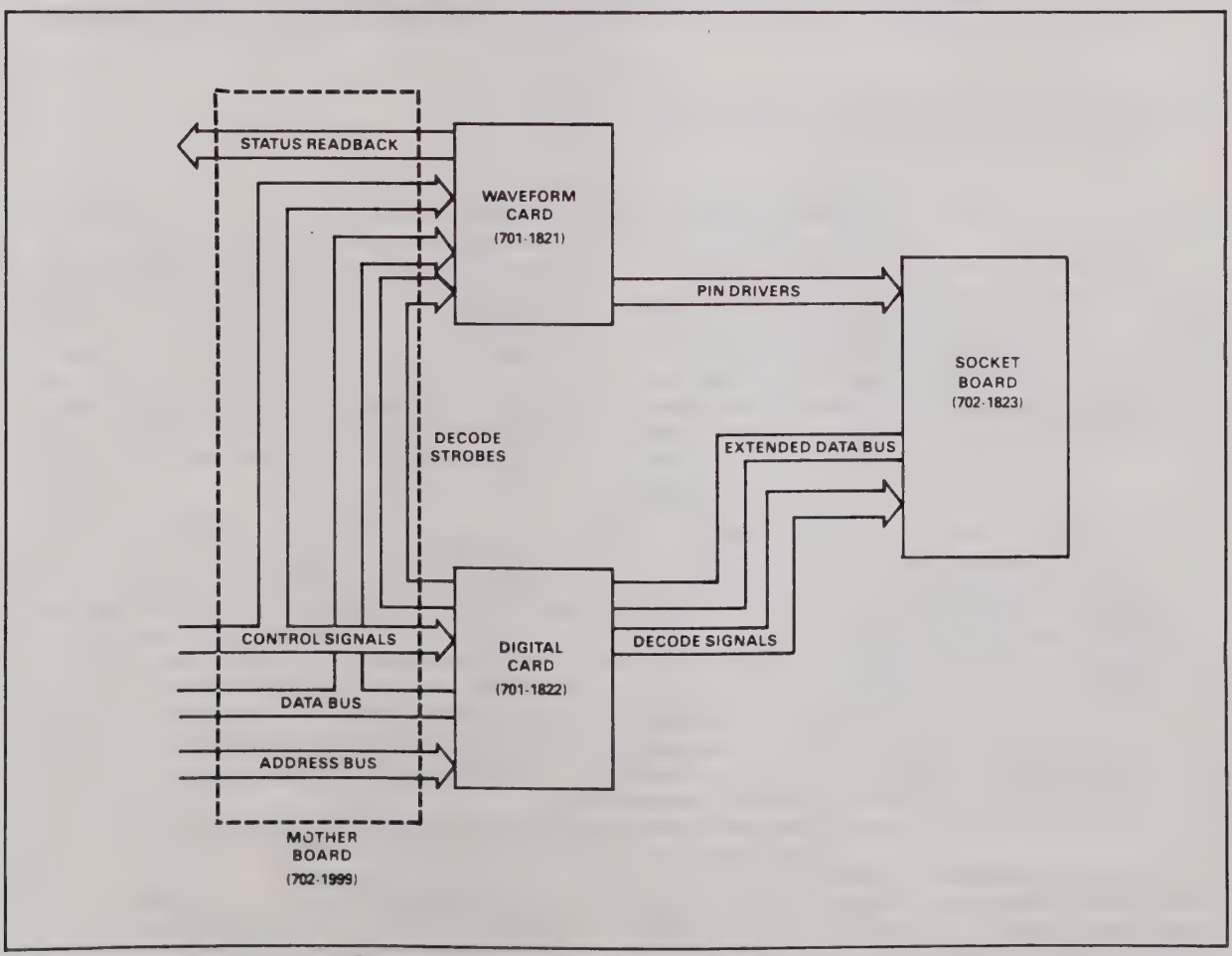


Figure 5-2. Block Diagram, GangPak™ Electronics

5.2.1 Digital Card

The digital card (shown in figure 5-3) provides the decode signals and software for the GangPak™. Decoding is accomplished with a PROM, a three to eight line decoder and AND gates connected to the 15 high-order address lines and the write/read line. The signals used in decoding are first conditioned with transparent latches to ensure stable levels. Edge-sensitive decode strobes are conditioned with "OR" gates utilizing the system clock ($\overline{V02}$). The gate enable control block (figure 5-3) consists of a programmable logic array (PAL™) and an octal latch. This block works in conjunction with the data gate write/read control lines to allow selection of one of the eight socket board data gates to be read. The extended data bus is buffered on this card by a transceiver. The software to drive the GangPak™ is contained in a single 8K PROM with expandability to 16k bytes.

5.2.2 Socket Card

The socket card (shown in figure 5-4) provides device addressing, device data gating, backward device test gating, a distributes the signals generated by the waveform generator card. The device address from A0 to A10 is generated by a pair of two octal latches connected to all sockets in parallel. Address line A9 also has the capability to be switched to the super voltage level provided by the waveform card.

The unused portion of the high-order address driver is used to select a device for backward device testing. When the device test mode is activated, pin 17 on all sockets is disconnected electrically from its associated data gate. Backward device sensing circitry on the waveform card is multiplexed to this pin on the selected device.

As can be seen in Figure 5-4, an individual data gate is provided for each socket. The data gate consists primarily of a bi-directional, latched transceiver configured for two modes of operation. Data can be latched to the socket or data from the socket can be output to the extended data bus. When in the write mode, the write select register provides the clock pulse to latch data into the appropriate data gate. The mode is selected by the state of the data gate write/read control line. This control line is a latched signal that orginates from a register in the programmer.

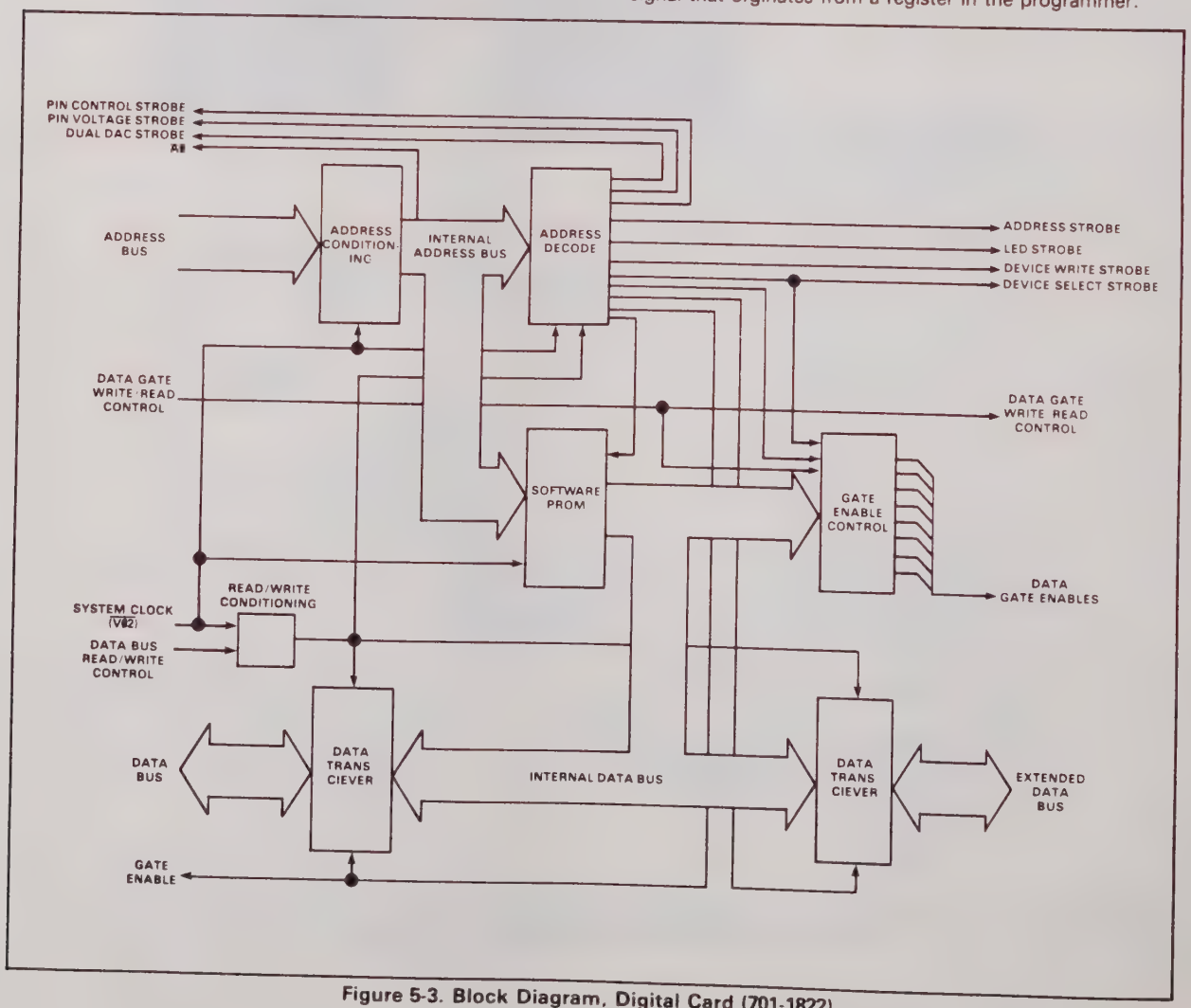


Figure 5-3. Block Diagram, Digital Card (701-1822)

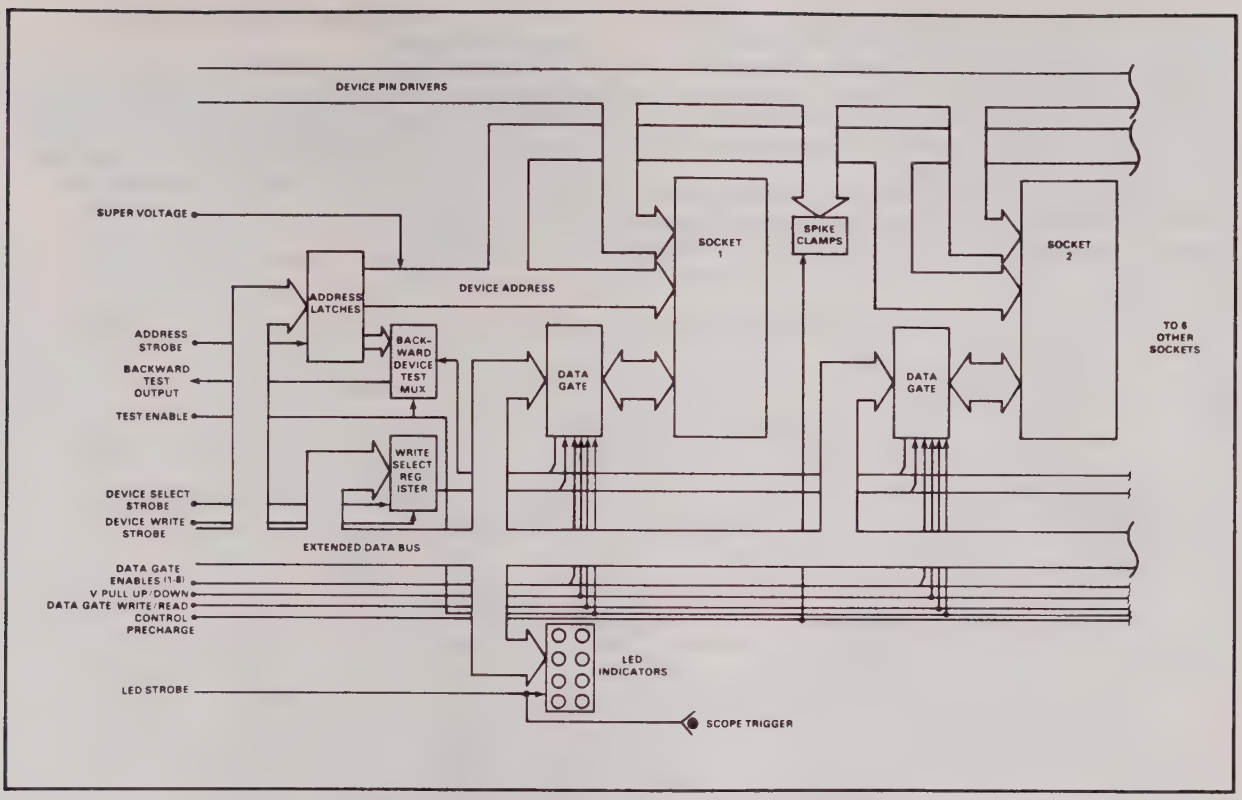


Figure 5-4. Block Diagram, Socket Board (702-1823)

When in the read mode, data from the selected socket is strobed onto the extended data bus when its enable is activated. This enable is generated on the digital card.

The pin driver outputs are distributed to each socket in parallel as shown in figure 5-4. Spike suppression circuitry is provided on the socket card for pin drivers 1, 22, and 23. The capacitor in the spike clamp circuitry is charged by the precharge line to a level above which spikes will be suppressed.

5.2.3 Waveform Card

The waveform card supplies the voltage needed to power and configure the PROMs inserted in sockets on the socket card. The primary components of the waveform card are the pin driver circuits, over current shutdown and reference generators, backward and register test circuitry, device data line pull-up/pull-down circuitry and the super-voltage circuitry (see figure 5-5). There are three basic types of pin drivers, characterizable by their output. These are the logic pin drivers, multivoltage pin drivers, and V_{CC} pin drivers.

Pin 2, 20, and 27 comprise the logic pin drivers. Logic levels for these pins are directly generated by the pin control register.

The multivoltage pin drivers are composed of pins 1, 22, and 23. These pins are programmable to four different levels; Ø logic low, logic high (V_{CC} DAC), V_{IHH} (+14.5 volts) and the V_{PP} (26 volts) DAC output. Switching between these levels is accomplished by the multiplexer (MUX) which is controlled primarily by the pin volt register (see figure 5-5). Two bits within the pin volt register are used to select which reference level is to be connected to the power amplifier output stage of the pin driver. The logic low and V_{IHH} are fixed references while the V_{PP} and logic high references are programmable. The logic high reference level tracks the output of the V_{CC} supply. "OR" gates are used to merge the outputs of the pin volt and pin control registers to allow logic level control of these pins by either register.

Pins 26 and 28 comprise the V_{CC} pin drivers. V_{CC} voltages are generated by a switching regulator that is programmable by the V_{CC} DAC output. Pin 28 always carries the output of the switching regulator. Pin 26, however, can either supply the output of the switching regulator or a logic level output, depending upon the state of the pin 26 control line. This control line originates from a register in the programmer. When the switcher output is selected for pin 26 its output pull-up transistor (Q7) is staturated and feedback for the pulse width modulator is sensed at pin 26's output. When logic levels are desired on pin 26, the pulse width modulator receives its feedback from the pin 28 output while pin 26 output tracks the state of a bit in the pin control.

Overcurrent conditions are sensed pin drivers 1, 22, 23, 26, and 28. These sense lines are routed to the overcurrent latch where they are integrated to disregard instantaneous current surges. Once an overcurrent condition has been detected, all reference generators are set to zero volts, thus shutting down the drivers.

Backward and misregister device test circuitry operate using the same principle. The pin under test is pulled negatively and the resultant level is sensed. This level is compared to a fixed reference or, in the case of the backward test, a programmable level. Output from the comparitors are routed to a buffer in the programmer where they can be read by the processor.

The pull-up/pull-down amplifier (amp) provides the voltage for the data gate pull-up/pull-down resistors on the socket card. The amp tracks the output of a bit in a programmer register.

The super voltage amp has a fixed output of +12 volts. Its output can be switched onto the super volt line which is routed to the socket card. Once switched on, its output will override the output of the address driver on the socket card for pin 24. The switch is controlled by a register in the programmer.

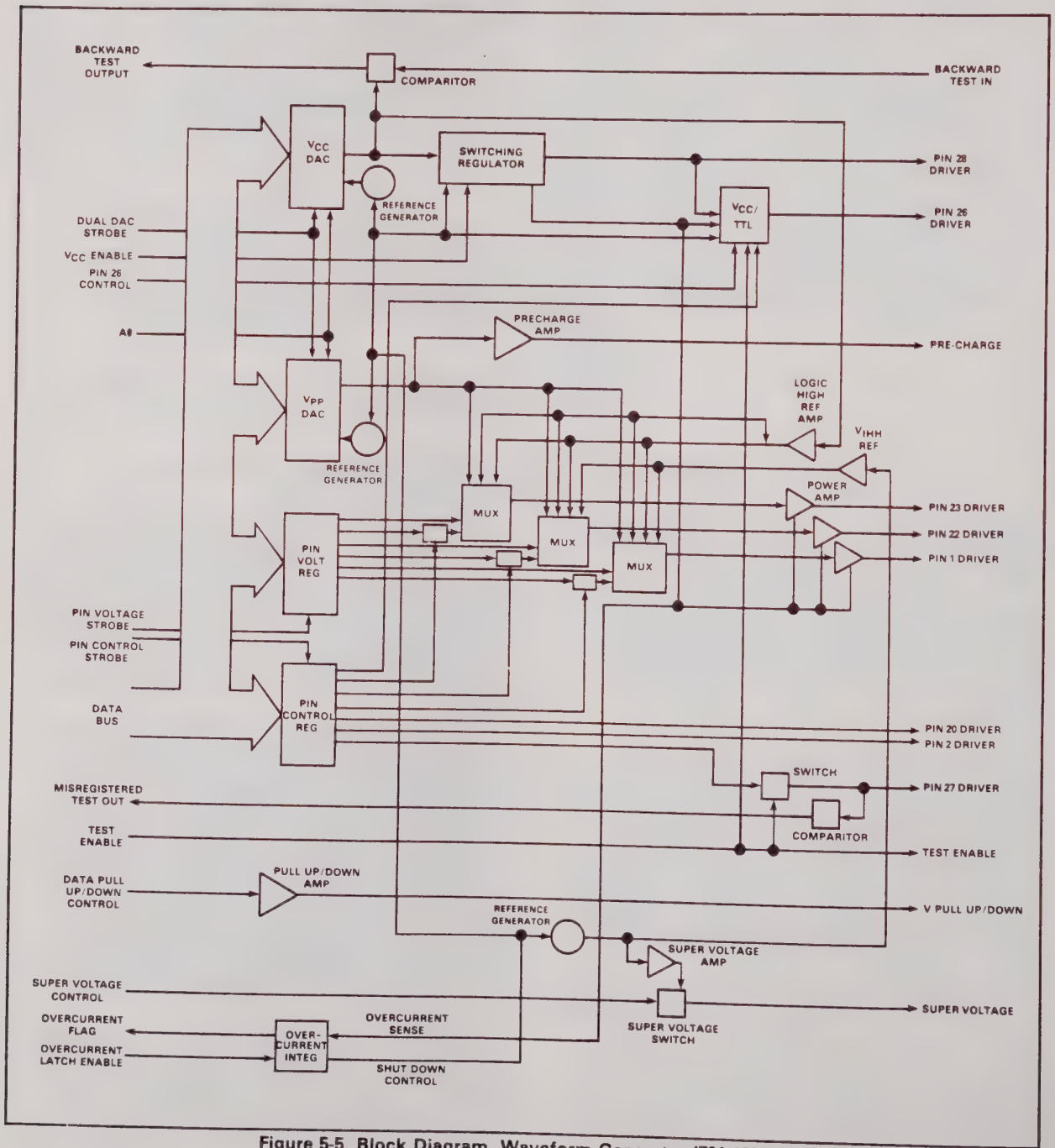


Figure 5-5. Block Diagram, Waveform Generator (701-1821)

SCHEMATICS

30-701-1822	Digital Card
30-701-1821	Waveform Generator
30-702-1823	Socket Board
30-702-1999	Motherboard

REVISIONS					
LTR	DESCRIPTION	DR	CHK	APPR'D	DATE
A	RELEASE	A.K.			

ADDRESS LATCHES

U2 74HC373

ADDRESS DECODE

U3 512 X 8 TS

U4 74HC32 4 PLACES

STROBE CONDITIONING

SOFTWARE PROM

U1 2764/ 27128

U8 74HC373

U9 7409 3 PLACES

DIRECT PAGE DECODE

U10 74HC04

U7 74HC138

DIRECT PAGE ENABLES

U9 7409

U11 74HC00 4 PLACES

R/W TRANSPARENT LATCH

READ SELECT REGISTER

DATA XCVR ENABLE CONTROL

U5 74HC374

U6 PAL 10L8

U13 74SC245

U12 74SC245

R1A, 1K
R1B 1K
R1C, 1K
R1D, 1K
R1E, 1K
R1F, 1K
R2A, 1K
R2B, 1K
R2, 1K
R3, 1K 1/4W, 5%
R4 3.3K
C1 10 20V
C2 .1
C4,5,6,7,8,9,10 .01
C3, 100pF, 100V
CR1, 1N4148

P1

A15	J	32	R/W
A14	8	31	
A13	H	28	SPARE
A12	7	HH	PINCNTL STB
A11	F	FF	PINVOLT STB
A10	6	EE	DUALDAC STB
A9	E	L	DEVW/R
A8	D	16	DO8
A7	C	15	DO7
A6	B	14	DO6
A5	A	13	DO5
A4	5	12	DO4
A3	4	11	DO3
A2	3	10	DO2
A1	2	9	DO1
A0	1	JJ	GATE ENABLE
AOL	27	Z	+24V
		21	+5V
		DD	GND
		23	GND
		26	GND
		Y	-9V

J1

11	DEVWRSTB
13	DEVW/R
10	DEVSELSTB
12	LEDSTB
9	ADLOSTB
8	ADHISTB
17	G8EN
16	G7EN
15	G6EN
14	G5EN
42	G4EN
41	G3EN
40	G2EN
39	G1EN
29	SKTDAT 7
28	SKTDAT 6
27	SKTDAT 5
26	SKTDAT 4
4	SKTDAT 3
3	SKTDAT 2
2	SKTDAT 1
1	SKTDAT 0

J1

+24	+24V
+5	+5V
	+5V
	+5V
	GND
	GND
	GND
	GND
	GND
-9	-9V

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE IN OHMS, 1/3W, 2%
2. ALL CAPACITORS ARE IN MICROFARADS, 50V.
3. LAST REFERENCE DESIGNATOR USED R4, , U13, P1, J1, CR1, C10.
4. POWER AND GROUND NOT SHOWN

REF. DES.	+5	GROUND
U4, 9, 10, 11	14	7
U7	16	8
U2, 3, 5, 6, 8, 12, 13	20	10
U1	28	14

5. UNUSED GATES:

U10 74HC04, 5 PLACES

APPROVALS:		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.		DATA I/O	
DSN. ENGR.	DATE	TOLERANCES, UNLESS OTHERWISE SPECIFIED XX ± .XXX ± ANGULAR		TITLE SCHEMATIC DIAGRAM, DIGITAL BOARD	
MFG. ENGR.	DATE				
QUAL. ASSUR.	DATE	DRAWN BY AKLUG, BV	DATE	SIZE D	CODE IDENT NO 54193
ENGR. MGR.	DATE	CHECKED BY.	DATE	DRAWING NO 30-701-1822	
				SCALE NONE	SHEET 1 OF 1

LTR	DESCRIPTION	DR	CHK	APPR'D	DATE
A	RELEASE	CL			
B	ECN 4825	MF			4-21-83
C	ECN 4835	BV			5/27/83

P1

BACKTST U
VCCEN 35
P26VCC 18
PULCTL N
OCRESET K
OCFLG V
SENSE 24
OPERATE BB
+PROG 22
+48V 25
+24V Z
+18V LL
+5V 21
23
GND 26
DD
-5V AA
-9V Y

J1

46 BKTSTSNS
50
49 DEVP 28
25
48
47 DEVP 26
23
33 VPULL
7 TEST ENABLE
6
22
24
GND
34
36
37

BACKWARD DEVICE SENSE
VCC SWITCHING SUPPLY
OVERCURRENT LATCH

U5 LM148
U10 LM148
U13 HC32
U14 TL494
U19 LM148
U9 DG5043
U12 DG211
U11 7406
U10 LM148
U19 LM148
U11 7406
U12 DG211
U11 7406
U15 1436
U10 LM148
U19 LM148

VR1 TL014
R4 17.8K 1%
R89 1K
R67 10K 1%
R68 10K 1%
R42 56K
R43 5.1K
C34 .01
C21
C25 .001
R44 15K
R45 10K 1%
R55 10K 1%
R53 510
R54 510
R51 10
R52 10
C18 .001
R56 1.2 1/2W
R49 6.8K
C32
T1
CR16 5FF05
CR15 5FF05
L1 150uH
C33 100 20V
Q6 PN2907
TP2
R50 33K
R46 33K
R7 1K
CR4
CR9 1N4743A 13V
CR3
CR11
R20 470K
R47 33K
R31 100
Q7 IRF523
CR10
Q1 PN2907
R32 10K
R40 10K
Q5 PN2907
R41 10K
R39 10K
C31 .001
R57 10K
R30 1K
Q8 PN2222
R90 1K
R78 1K
Q14 PN2907
R77 3.3K
R76 2.2K
R83 3.3K
Q13 PN2222
R84 1K
C44
R85 2.2K
Q20 PN2907
R86 1.2 1/2W
R87 1K
R88 18K
Q19 PN 2222
R26 15K
R75 330
CR12
CR14 1N5991B 4.3V
CR13 1N5991B 4.3V
R71 1K
Q11 MJE240
R80 10K 1%
R81 56.2K 1%
C2
Q12 MJE240
C37
R69 10K 1%
R70 16.2K 1%
C28, C16
C15 22 15V
C45 2.2
C40 1
C30
C39,46 .1 100V
C17 10 63V
C42 22 15V
C35, C36, C38
C19, C23, C26 2.2
C27
C43 22 15V
C41 4.7

+48 +33V SUPPLY
+18 +13V SUPPLY
+33
+28
+24
+13
+5
-5
-9

A B C D
2.D6
E 2.D5
F 2.D4
G 2.D2
H 2.D2

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 1/4W AND IN OHMS, 5%.
2. ALL DIODES ARE 1N4148.
3. ALL CAPACITORS ARE IN MICROFARADS, 50V.
4. ALL CAPACITORS ARE .1 MICROFARADS.
5. ALL VOLTAGE REGULATORS ARE TL431.
6. PWR & GND CONNECTIONS NOT SHOWN:

I.C.	-9	-5	GND	+5	+13	+24	+48
U5	11				4		
U6,7,8	3		14		13		
U9	14		13	12		11	
U10		11				4	
U11,13			7	14			
U12	4		5	12		13	
U14			7		12		
U15		4					7
U16			1,5	17			
U17,18			10	20			
U19	11				4		

7. LAST REFERENCE DESIGNATOR USED: C46, CR16, J1, L1, P1, Q20, R90, T1, TP3, U19, VR4
8. UNUSED REF DESIGNATORS: C20, 21, 22
9. SPARE GATES:

U11 7406 2 PLCS

U19 LM148

APPROVALS		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	DATA I/O	
DSN. ENGR.	DATE 2/1/83	TOLERANCES UNLESS OTHERWISE SPECIFIED XX ± XXX ± ANGULAR	TITLE SCHEMATIC WAVEFORM GENERATOR	
MFG. ENGR.	DATE 3/1/83			
QUAL. ASSUR.	DATE 3/8/83	DRAWN BY	DATE 10/82	SIZE D
ENGR. MGR.	DATE 3/9/83	CHECKED BY:	DATE 1-19-83	CODE IDENT. NO. 54193
				DRAWING NO. 30-701-1821
			SCALE —	SHEET 1 OF 2

BRUNING 49270

8 7 6 5 4 3 2 1

REVISIONS					
LTR	DESCRIPTION	DR	CHK	APPR'D	DATE
C	SEE SHT 1				

P1

MISRTST 17

1.A6 A B C D

1.A4 E F

MULTI-VOLTAGE PIN DRIVERS

VCC FOLLOWER

U5 LM148 — R36 10.0K 1% — R35 11.5K 1%

R37 10K

VIHH REF

U5 LM148 — R38 15K

+18 — R60 10K — R61 10K — Q15 PN2907 — U11 7406 — R64 1.5K

R62 1.5K — R63 1.5K

VR2 — R59 10K 18T CW

VR3 — R79 10K 18T CW

VR4 — R82 10K 18T CW

U16 AD7528 (D7 D6 D5 D4 D3 D2 D1 D0; VRFB VRFA OUTB RFBB RFBA OUTA; Ā/B CS WR)

C29 10PF 100V — U5 LM148

AOL 27

DUAL DAC STB EE

PIN VOLTAGE REGISTER

U17 74HC374 (D Q CLK OE; NC NC)

U13 HC32 ×4

PINVOLT STB FF

PIN CONTROL REGISTER

U18 74HC374 (D Q CLK OE; NC)

D08 16
D07 15
D06 14
D05 13
D04 12
D03 11
D02 10
D01 9

PINCNTL STB HH

TESTENABLE M

SUPRVSWT PP

U12 D0211

TP3 — TP1

U6 6108 — U8 6108 — U7 6108 (S1 S2 S3 S4 S5 S6 S7 S8; EN; D; A1 A0 A2)

+5

R13 59.0K .1%,1/8W — R25 59.0K .1%,1/8W — R18 59.0K .1%,1/8W

R34 330

VPP FOLLOWER

R33 59.0K,.1%,1/8W — U1 1436 — C1 100PF,100V — R3 100 — R2 255K .1%,1/8W

R65 10.0K 1% — R66 35.7K 1% — U10 LM148

MISREGISTERED DEVICE SENSE

R27 1K — U19 LM148 — R73 10K — R74 10K

R6 470 — R5 470 — R8 470

R72 1M — R48 10K

U11 7406

+33 — R15 10 — LM318N U2 — C10 — C4 2.2 — C3 10PF,100V — R14 5.1K — C9 3.3PF,1KV — R10 255K .1%,1/8W — Q2 MJE2401 — Q16 PN2907 — R9 330 — R11 7.5K — +28

+33 — R29 10 — LM318N U4 — C14 — C8 2.2 — C7 10PF,100V — R28 5.1K — C13 3.3PF,1KV — R24 255K .1%,1/8W — Q4 MJE2401 — Q18 PN2907 — R23 330 — R19 7.5K — +28

+33 — R22 10 — LM318N U3 — C12 — C6 2.2 — C5 10PF,100V — R21 5.1K — C11 3.3PF,1KV — R17 255K .1%,1/8W — Q3 MJE2401 — Q17 PN2907 — R16 330 — R12 7.5K — +28

CR7 — CR1 — CR2 — R1 4.7K — CR5 — CR8 — CR6

1.A4 G — 1.A3 H — J1

45 DEVP23
20 DEVP22
44 DEVP1
30 PRECHARGE
35 SUPERV
21 DEVP27
31 DEVP20
19 DEVP2

APPROVALS		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES, UNLESS OTHERWISE SPECIFIED XX ± XXX ± ANGULAR	DATA I/O	
DSN. ENGR.	DATE		TITLE SCHEMATIC WAVEFORM GENERATOR	
MFG ENGR. K.T. Sumner	DATE 2/3/93			
QUAL ASSUR B. Lindsey	DATE 1/19/93	DRAWN BY	DATE 1/19/93	SIZE D — CODE IDENT. NO 54193 — DRAWING NO 30-701-1821
ENGR MGR	DATE 2/93	CHECKED BY B. Crandall	DATE 1-19-93	SCALE — SHEET 2 OF 2

BRUNING 49270

LTR	DESCRIPTION	DR	CHK	APPR'D	DATE
A	SEE SHEET 1				

GEN BUS (1,C3)
DEVADR BUS(1,C3)
BKWTST BUS(1,C3)
TESTENABLE (1,C3)
ALL (1,C3)
DISCHARGE (1,B3)
DEV W/R (1,B3)
DEVP BUS (1,B3)
WRITESEL BUS(1,B3)
SKTDAT BUS (1,B3)
DEV DATA CLAMP (1,B3)

U10 74HC646 — XU9 SOCKET 2 — R13 22K — CR21 TID121 — R16 1K — U30 4066 — C12 C13 — CR14 1N5819 — CR18 CR19 C19 CR20

U12 74HC646 — XU11 SOCKET 3 — R14 22K — CR25 TID121 — R17 1K — U33 4066 — C15 C14 — CR15 1N5819 — CR22 CR23 C20 CR24

U14 74HC646 — XU13 SOCKET 4 — R15 22K — CR26 TID121 — R18 1K — U33 4066 — C17 C18 — CR16 1N5819 — CR11 CR12 CR13 C16 — CR30 1N5819 C27 C28

U18 74HC646 — XU17 SOCKET 6 — R26 22K — CR32 TID121 — R23 1K — U30 4066 — CR28 1N5819 C24 C23

U20 74HC646 — XU19 SOCKET 7 — R20 22K — CR33 TID121 — R24 1K — U33 4066 — CR29 1N5819 C26 C25

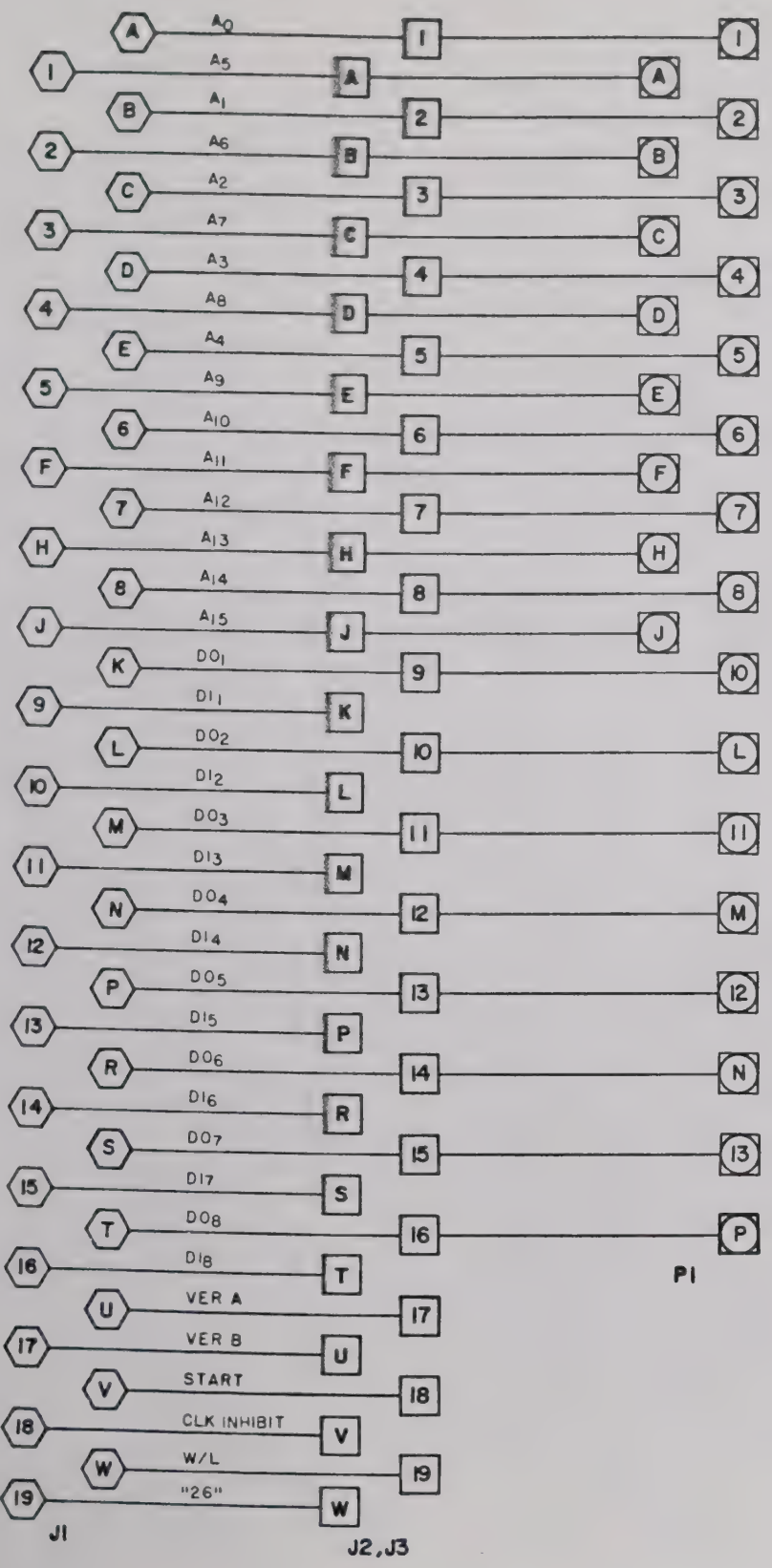
U22 74HC646 — XU21 SOCKET 8 — R27 22K — CR34 TID121 — R25 1K — U33 4066

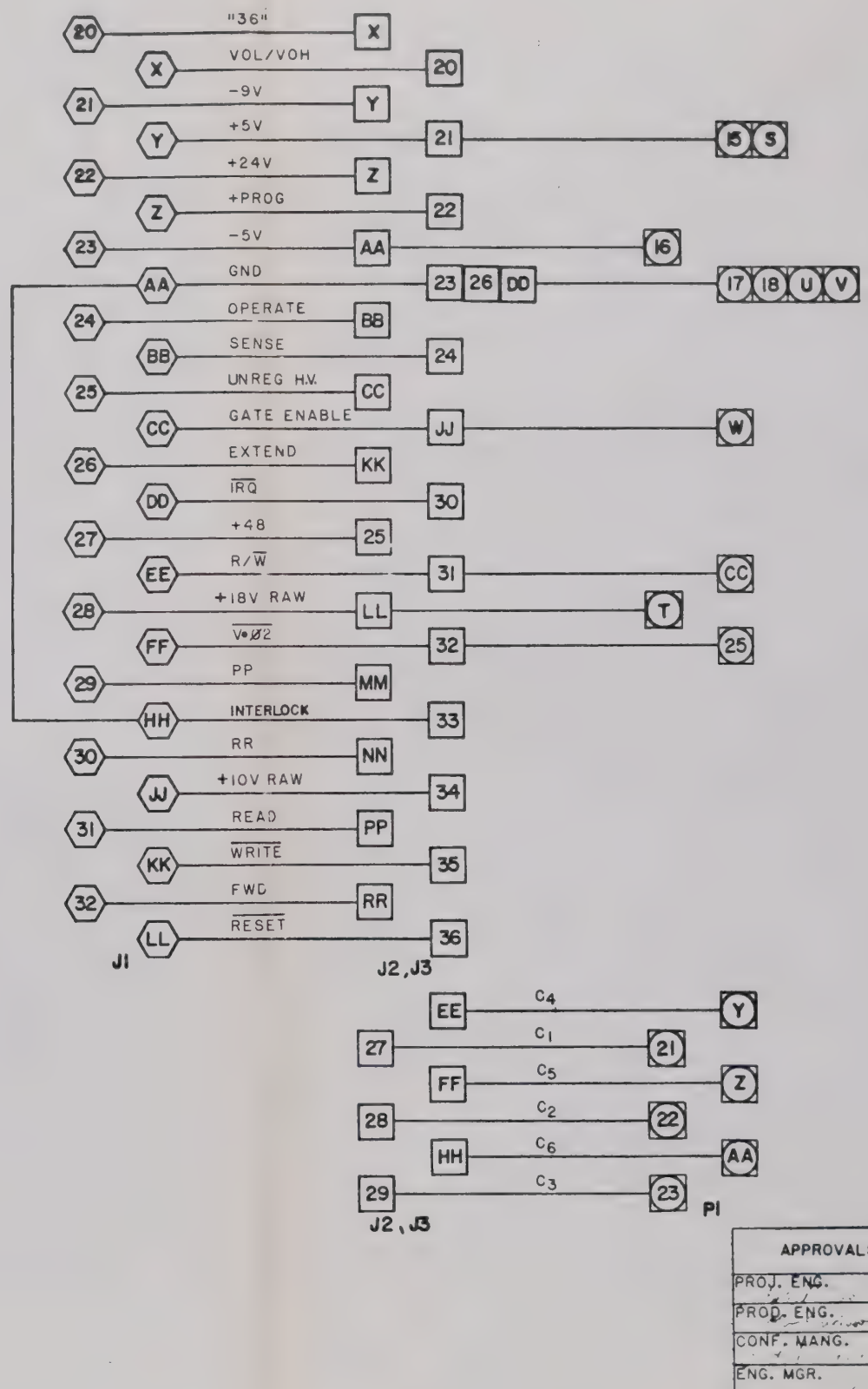
TITLE
SCHEMATIC DIAGRAM, SOCKET BOARD

SIZE	CODE IDENT NO	DRAWING NO
D	54193	30-702-1823

SCALE NONE — SHEET 2 OF 2

REVISIONS					
ZONE	LTR	DESCRIPTION	DWN	CK	PE	DATE
	A	RELEASE	[illegible]	[illegible]		1-80





APPROVALS	TOLERANCES (EXCEPT AS NOTED)	DATA I/O
PROJ. ENG.	DECIMAL ± ANGULAR ±	TITLE SCHEMATIC DIAGRAM UniPak MOTHERBOARD
PROD. ENG.		
CONF. MANG.	DRAWN BY G RYDER	SIZE D · CODE IDENT NO · DRAWING NO 008-1999
ENG. MGR.	CHECK	SCALE NA · SHEET 1 OF 1
DATE 1-17-80		

APPENDIX A

FAMILY CODES AND PINOUT CODES TABLE

AND

ERROR CODES

Table A-1. Family Codes and Pinout Codes

PROM Part Number	Family Code	Pinout Code	Notes
Advanced Micro Devices			
2716 AM9716	19	23	P
2732 AM9732	19	24	P
2764 AM9764	AF	33	P
27128	AF	51	P
Electronic Arrays			
2716	19	23	P
Fujitsu			
B516	19	23	I
2732A	27	24	I
2732A 35	27	24	I
B532	27	24	I
2764	45	33	I
27C64	45	33	I
27128	45	51	I
27C128	45	51	I
General Instruments			
5716	83	23	P
5816	37	23	P
Hitachi			
462532	19	25	I
462716	19	23	I
462732	19	24	I
462732P	19	24	I
48016	33	23	I
482732A	27	24	I
482764	79	33	I
4827128	79	51	I
Intel			
2716	19	23	P
2732	19	24	P
2732A	27	24	P
2764	79	33	P
2815	85	23	P
2816	37	23	P
27128	79	51	P
27256	93	32	P
Mitsubishi			
2716	19	23	I
2732	19	24	I
2732A	27	24	I
2764	79	33	I
27128	79	51	I
Mostek			
2716	19	23	O
Motorola			
MCM2532	19	25	P
MCM2716	19	23	P
MCM2816	43	23	P
MCM2817	81	71	P
MCM2832	81	70	P
MCM68764	25	29	P
MCM68766	25	29	P

PROM Part Number	Family Code	Pinout Code	Notes
National Semiconductor			
2532	19	25	P
25C32	19	25	P
2716	19	23	P
27C16	19	23	P
2732	19	24	P
27C32	19	24	P
2758A	19	22	P
2764	35	33	P
2816	37	23	P
9716	B3	23	P
Nippon Electric Company, Ltd.			
2716	19	23	I
2732	19	24	I
2732A	27	24	I
2764	79	33	I
27128	79	51	I
Oki			
2716	19	23	I
2758	19	22	I
2532	19	25	I
2732	19	24	I
2732A	27	24	I
2764	79	33	I
27128	79	51	I
Ricoh			
RD5H32	27	24	P
RD5H64	25	29	P
Seeq			
5213	A5	23	P
5133	35	33	P
Signetics			
2716	19	23	P
2732	19	24	P
Texas Instruments			
2508	19	22	P
2516	23	28	P
2716	19	23	P
2532	19	25	P
2732	19	24	P
2564	31	30	P
2764	35	33	P
Toshiba			
323	19	23	I
2732	19	24	I
2732A	27	24	I
2764	79	33	I
27128	79	51	I
2732D	19	24	I
Xicor			
2804	37	82	P
2816	37	23	P

KEY TO HEADINGS

- **Device Part Number**. The number assigned by the device manufacturer.
- **Family Code**. A 2-digit number that designates the programming algorithm.
- **Pinout Code**. A 2-digit number used to differentiate device types based on pin assignment and array size.
- **GangPak™ Model Revision Version**. A number in this column specifies the earliest software version of the GangPak™ that will program the device to the manufacturer's latest specifications.
- **Notes**. The following is an explanation of the letters that appear in the Notes column.
  - O - This device is obsolete and no longer in production.
  - I - The algorithm is installed in the production units that have been shipped but the approval process is not complete. Approval is in progress.
  - P - The algorithm is installed and fully approved by the manufacturer.

Table A-2. Error Codes

CODE	NAME	DESCRIPTION	CORRECTIVE ACTION
21	Illegal-Bit	The device has previously programmed bits of opposite polarity to programming data.	Remove device and erase it.
23	First-Pass Verify	The device data was incorrect on the first pass of of the automatic verify sequence during device programming.	Remove device(s) that Failed and reverify the rest.
24	Second-Pass Verify	The device data was incorrect on the second pass of the automatic verify sequence during device programming.	--
27	Insufficient RAM	RAM required for the operation exceeds the available amount.	Check for correct begin RAM address, word count of device or block size selected, and set size and word size.
31	Excessive Current Drain	The operation aborted due to excessive current drain by a device.	Remove devices. If problem persists, a hardware failure may have occurred that requires servicing.
32	Backward Device	The operation aborted due to a device being inserted upside down.	Reinsert backward device.
35	Faulty Chip Select	The operation aborted due to device data drivers being still active when device chip enables de-selected.	Remove device. If problem persists, a hardware Failure may have occurred that requires servicing.
38	Illegal Calibration Operation	Nonexistant calibration step number or calibration step invoked without family code and/or pinout code selected.	See calibration chart for proper operational procedures.
63	Faulty Load	Device data Failed to transfer to RAM correctly.	Repeat load operation.
98	Incorrect Block Size	Block size selected exceeds word count of the device.	Reset block size value.
A5	Device Data Fault	Data outputted by device changes under varying bad conditions.	Reinsert device. If problem persists replace the device.
A6	Misregistered Device	A 24-pin device has been inserted that is making contact with the upper portion of the socket.	Be sure that all devices have been properly inserted. If the error occurs when a 28-pin device is inserted, check to be sure the correct family pinout code has been used.
A7	Incorrect Set Word Size Combination	Set size (automatically calculated during load or selected manually) and word size combination exceeds unit's capabilities.	Check for correct set size and word size selections.
A8	Incorrect Family Code and/or Pinout Code	Improperly selected family code and/or pinout code.	Refer to the family code (table A-1) for correct device code.
A9	Illegal Insertion	A device has been inserted in a socket that must be empty.	Remove device(s) that are in the wrong socket(s).
A1	No ID Found	The device does not have an electronic identifier.	Operations using this device require normal family pinout entry.
A2	Invalid ID	The device has an electronic identifier which is incompatable with the other inserted devices or has an unrecognized electronic identifier.	Remove violating

MEASUREMENT CHART

REVISIONS

LTR	DESCRIPTION	P E	DATE
A	Release	dg	5/2/83

GangPak™ Measurement Chart

STEP	TEST NO.	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
			The following test is performed with					
			the GangPak™ on the calibration extender:					
1	1	Reference calibrate	701-1821/TP1	-3.42	-3.37	-3.32	R59,701-1821	
	2	V_{PP} calibrate	701-1821/TP3	-5.15	-5.10	-5.05	R82,701-1821	
	3	V_{CC} calibrate	701-1821/TP2	4.95	5.00	5.05	R79,701-1821	
			The remaining tests are performed with					
			the GangPak™ installed in its normal					
			operating position:					
2	4	V_{CC} linearity check	2/28	10.90	11.00	11.10		
	5	V_{PP} linearity check	2/1,22,23	14.90	15.00	15.10		
3	6	V_{CC} linearity check	2/28	2.90	3.00	3.10		
	7	V_{PP} linearity check	2/1,22,23	5.90	6.00	6.10		
4	8	Cold socket test	A11/A11	-0.10		0.40		Note that all LEDs are off. Error indicated if socket data lines are not tristate. LED's indicate problem sockets.
5	9	V_{CC}	A11/28	6.60	6.70	6.80		
	10	V_{CC} load	2/28	6.40				Connect a 5Ω ,10W resistor between pins 28 and 14 of socket 2.

REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DH	5/26/83

GangPak™ Measurement Chart

STEP	TEST NO.	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
5	11	V_{CC} overcurrent						Briefly touch a 2Ω ,5W resistor between pins 28 and 14 of socket 2. Note: beeps and LEDs flash.
	12	Overcurrent shutdown	A11/A11	-0.10		0.40		
6	13	Pin 26 V_{CC}	A11/26	6.60	6.70	6.80		
	14	Pin 26 V_{CC} load	2/26	6.40				Connect a 5Ω ,10W resistor between pins 26 and 14 of socket 2.
	15	Pin 26 V_{CC} overcurrent						Briefly touch a 2Ω ,5W resistor between pins 26 and 14 of socket 2. Note: beeps and LEDs flash.
7	16	Pin 26 sink overcurrent						Briefly touch a 25Ω ,5W resistor between pins 26 and 28 of socket 2. Note: beeps and LEDs flash.
8	17	Pin 1 V_{PP}	A11/1	17.9	18.0	18.1		
	18	Pin 1 V_{PP} load	2/1	17.8				Connect a 50Ω ,10W resistor between pins 1 and 14 of socket 2.

REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DM	5/2/83

GangPak™ Measurement Chart

STEP	TEST NO	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
8	19	Pin 1 Vpp overcurrent						Briefly touch a 25Ω ,5W resistor between pins 1 and 14 of socket 2. Note: beeps and LEDs flash.
9	20	Pin 1 V_{IHH}	2/1	14.0	14.5	15.0		
	21	Pin 1 sink overcurrent						Touch a 3300Ω resistor between pins 1 and 23 of socket 2. Note: beeps and LEDs flash.
10	22	Pin 22 Vpp	A11/22	17.90	18.00	18.10		
	23	Pin 22 Vpp load	2/22	17.80				Connect a 50Ω ,10W resistor between pins 22 and 14 of socket 2.
	24	Pin 22 Vpp overcurrent						Briefly touch a 25Ω ,5W resistor between pins 22 and 14 of socket 2. Note: beeps and LEDs flash.
11	25	Pin 22 V_{IHH}	2/22	14.0	14.5	15.0		

REVISIONS

LTR	DESCRIPTION	P.E	DATE
A	Release	PJJ	5/26/93

GangPak™ Measurement Chart

STEP	TEST NO.	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
	26	Pin 22 sink overcurrent						Touch a 3300Ω resistor between pins 22 and 23 of socket 2. Note: beeps and LEDs flash.
12	27	Pin 23 Vpp	A11/23	17.90	18.00	18.10		
	28	Pin 23 Vpp load	2/23	17.80				Connect a 50Ω ,10W resistor between pins 23 and 14 of socket 2.
	29	Pin 23 Vpp overcurrent						Briefly touch a 25Ω ,5W resistor between pins 23 and 14 of socket 2. Note: beeps and LEDs flash.
13	30	Pin 23 V_{IHH}	2/23	14.00	14.50	15.00		
	31	Pin 23 sink overcurrent						Touch a 3300Ω resistor between pins 22 and 23 of socket 2. Note: beeps and LEDs flash.
14	32	Address, data and controls high	A11/2,4,6,8,10,12,15,17,19, 21,23,25,27	4.00		5.50		
	33	Address, data and controls low	A11/1,3,5,7,9,11,13,16,18,20, 22,24,26,28	-0.10		0.40		

REVISIONS

LTR	DESCRIPTION	P E	DATE
A	Release	DG	5/1/83

GangPak™ Measurement Chart

STEP	TEST NO	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
15	34	Address, data and	A11/2,4,6,8,10,12,15,17,19	-0.10		0.40		
		controls low	21,23,25,27					
	35	Address, data and	A11/1,3,5,7,9,11,13,16,18,20,	4.00		5.50		
		controls high	22,24,26,28					
16	36	A9 supervoltage	2/24	11.80	12.00	12.20		
17	37	Device 1 backward						Note lighted LED on socket 1.
								Note beeps and flashing LEDs
								when 470Ω resistor is
								connected between pins 17
								and 14 of socket 1.
18	38	Device 2 backward						Same as step 17, except socket 2.
19	39	Device 3 backward						Same as step 17, except socket 3.
20	40	Device 4 backward						Same as step 17, except socket 4.
21	41	Device 5 backward						Same as step 17, except socket 5.
22	42	Device 6 backward						Same as step 17, except socket 6.
23	43	Device 7 backward						Same as step 17, except socket 7.
24	44	Device 8 backward						Same as step 17, except socket 8.

REVISIONS

LTR	DESCRIPTION	P E	DATE
A	Release	DJ	5/26/83

GangPak™ Measurement Chart

STEP	TEST NO.	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
25	45	Misregistered device						Note beeps and flashing LEDs when 470Ω resistor is connected between pins 27 and 14 of socket 1.
26	46	V_{CC} sawtooth	2/28					Connect a 100Ω ,1W resistor between pins 28 and 14 of socket 2. Observe waveform as shown on last page of this table.
	47	V_{PP} sawtooth	2/1,22,23					Observe waveform as shown at end of this table.
27	48	Switching Pin Drivers	2/1,22,23					Observe waveform photo (at end of this table).
			The following tests are used for verification of particular family and pinout characteristics and are not required for calibration.					
28	49	Static first pass verify levels						See family characteristics table associated with the selected family timing diagram.

REVISIONS

LTR	DESCRIPTION	P E	DATE
A	Release	DG	5/26/83

GangPak™ Measurement Chart

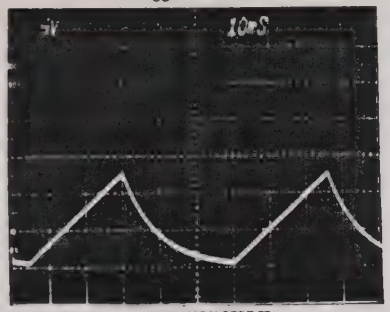
STEP	TEST NO.	TEST DESCRIPTION	MEASUREMENT LOCATION CIRCUIT SOCKET/PIN BOARDS/TEST POINTS	MEASUREMENT MIN	MEASUREMENT NOM	MEASUREMENT MAX	ADJUSTMENT LOCATION	COMMENTS
29	50	Static second pass verify levels						See family characteristics table associated with the selected family timing diagram.
30	51	Static program inhibit levels						See family characteristics table associated with the selected family timing diagram.
31	52	Address increment loop						Address bus of selected pinout is incremented approximately every 100 µs.
32	53	Programming waveforms						See waveforms for selected family
33	54	Erase waveforms						See waveforms for selected family. Fatal error if non-electrically erasable family selected.

Measurement Chart

PROGRAM ELECTRONICS GANG PAK™

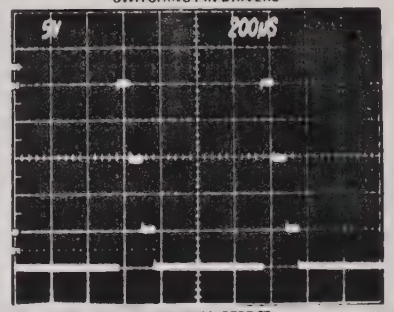
DATE	REV	REVISION RECORD	DR	CK
5/26/83	A	Release	Dg	Ec

V_{CC} SAWTOOTH



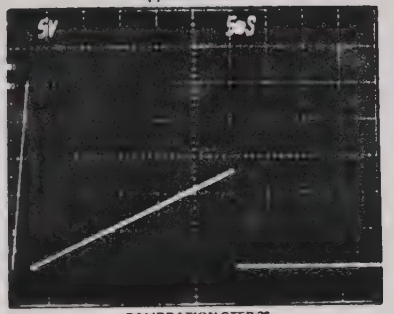
CALIBRATION STEP 26

SWITCHING PIN DRIVERS



CALIBRATION STEP 27

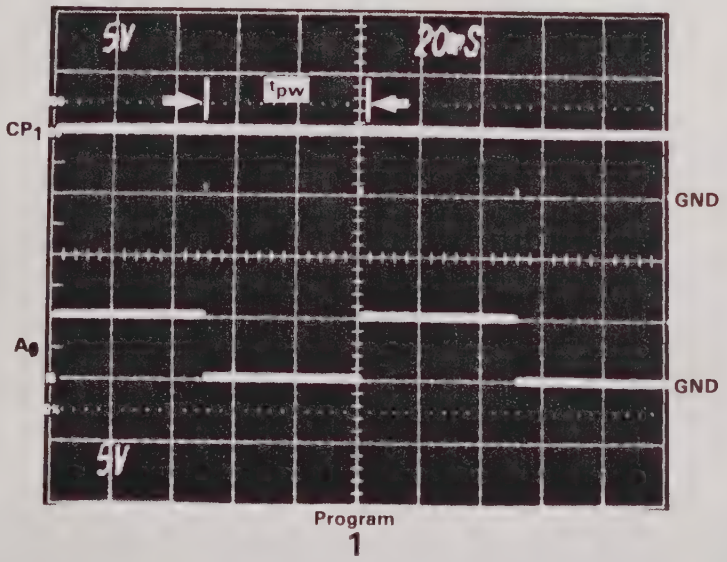
V_{PP} SAWTOOTH



CALIBRATION STEP 28

TIMING DIAGRAMS
For
FAMILY CODES

19, 1A
25, 26
27, 28
31, 32
33, 34
35, 36
37, 38
43, 44
45, 46
79, 7A
81, 82
83, 84
85, 86
93, 94
A5, A6
AF, B0
B3, B4
B9, BA


5V
20mS
tpw
CP1
GND
A0
GND
5V
Program
1

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	48		52	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}				V	
ERASE	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC. = maximum V_{CC} + 0.5 VDC.*
   V_{IL} = minimum - 0.1 VDC. = maximum 0.8 VDC.
3. *Pulsed from V_{IL}.*

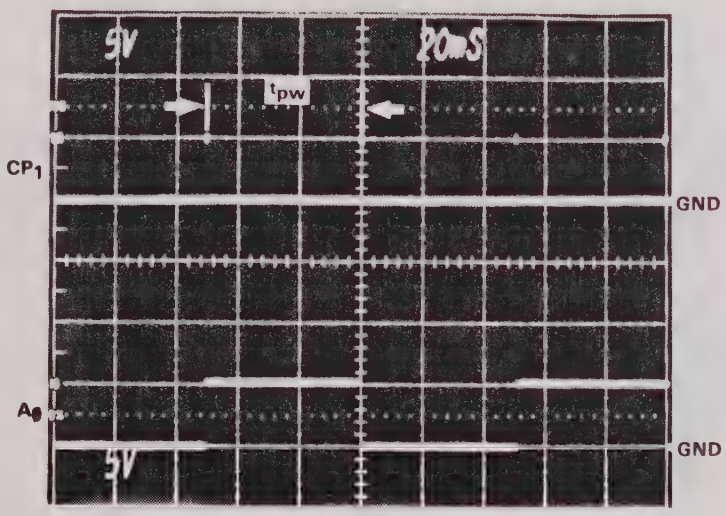
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DA	5/12/-

TIMING DIAGRAM

FAMILY CODES 19, 1A

DATA I/O



1

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IL}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	48		52	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP ERASE	V_{CC}				V	
	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	
	t_f (V_{PP})				µsec	
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC
3. *Pulsed from V_{IH}.*
4. *This Family Characteristics table is to be used with pinouts 24, 25, 49 & 50. All other pinouts see sheet 1.*

REVISIONS

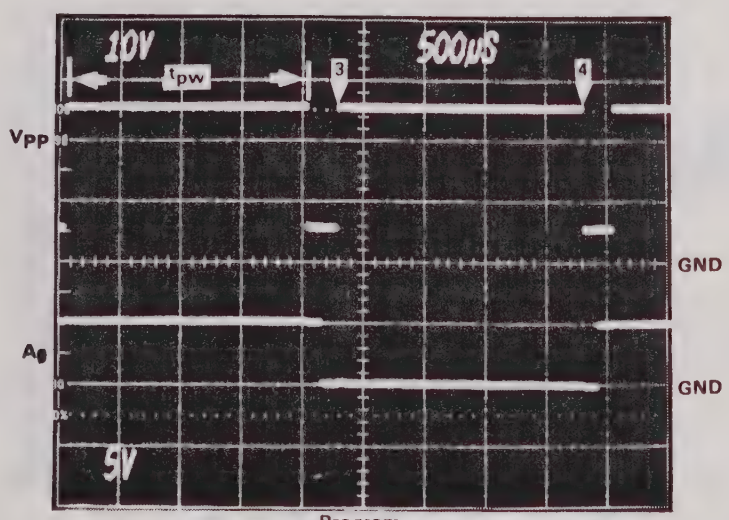
LTR	DESCRIPTION	P.E.	DATE
A	Release	[illegible]	5/15/85

TIMING DIAGRAM

FAMILY CODES 19, 1A

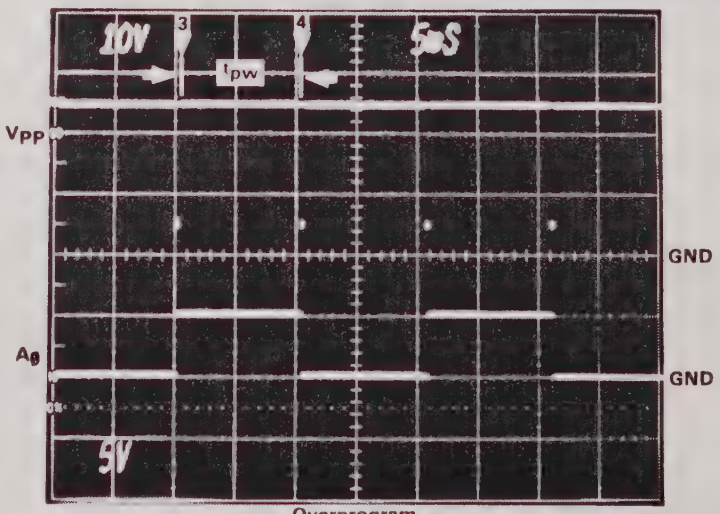
DATA I/O

0526 1282



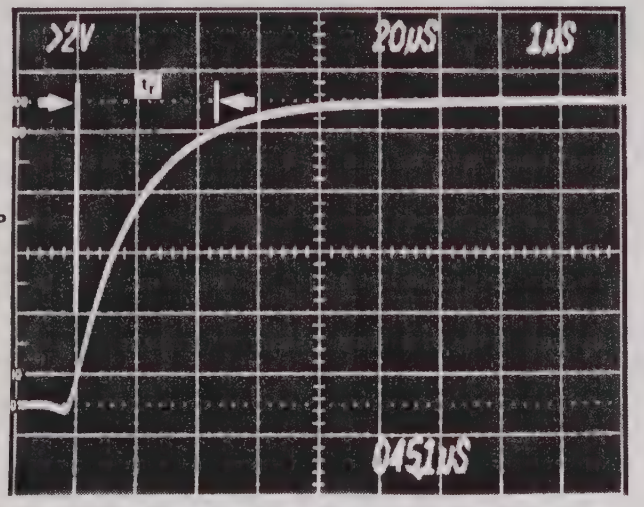
Program

1

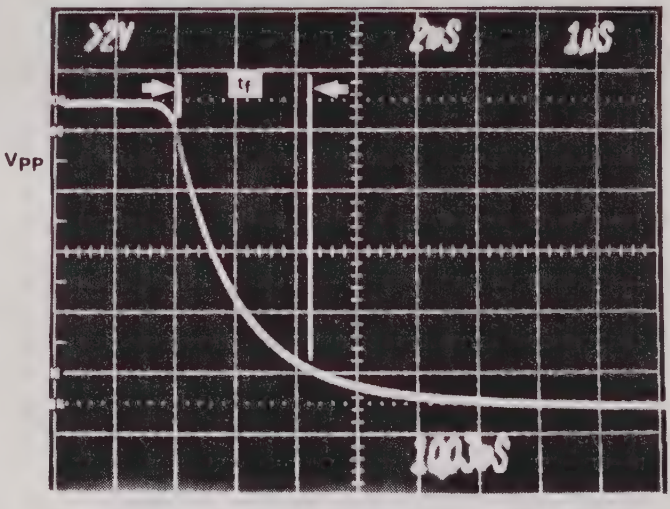


Overprogram

2



3



4

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	See note 3
	t_r (V_{PP})	0.5		4.0	µsec	10% - 90%
	t_f (V_{PP})	0.5		4.0	µsec	10% - 90%
	CP_1		V_{IH}		V	See note 2
	CP_2		V_{IL}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	1.9		2.1	msec	
	Pulse Count	1		20		Per byte
	Overprogram t_{pw}	9.6		10.4	msec	
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP ERASE	V_{CC}				V	
	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{CC}.*

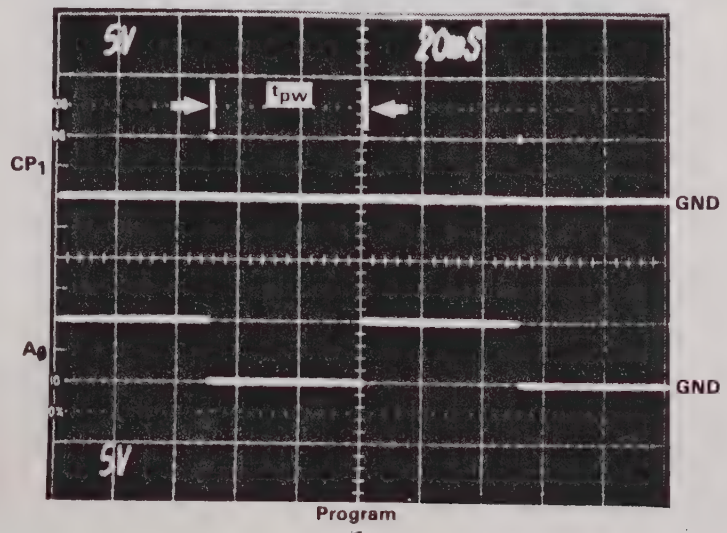
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DY	5/10/: :

TIMING DIAGRAM

FAMILY CODES 25, 26

DATA I/O


5V
20mS
t_{pw}
CP_1
GND
A_8
GND
5V
Program
1

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.5	21.0	21.5	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	48		52	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}				V	
ERASE	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1 *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*

2 V_{IH} = *minimum 2.2 VDC.*
= *maximum* V_{CC} + *0.5 VDC.*

V_{IL} = *minimum −0.1 VDC.*
= *maximum 0.8 VDC.*

3. *Pulsed from* V_{IH}.

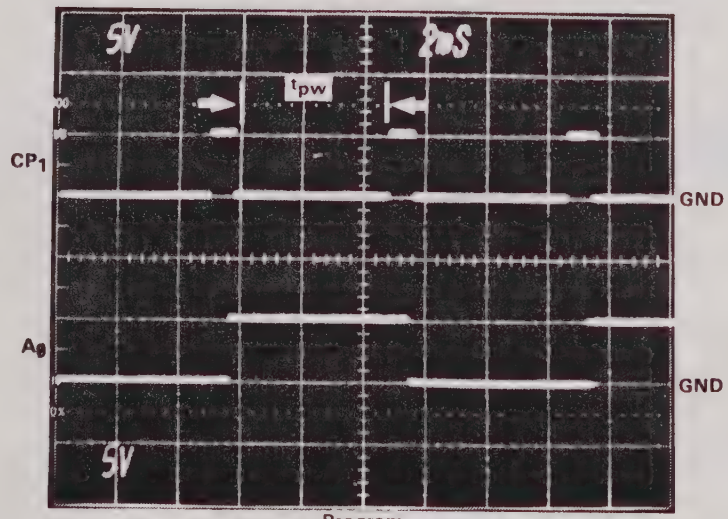
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DG	5/10/83

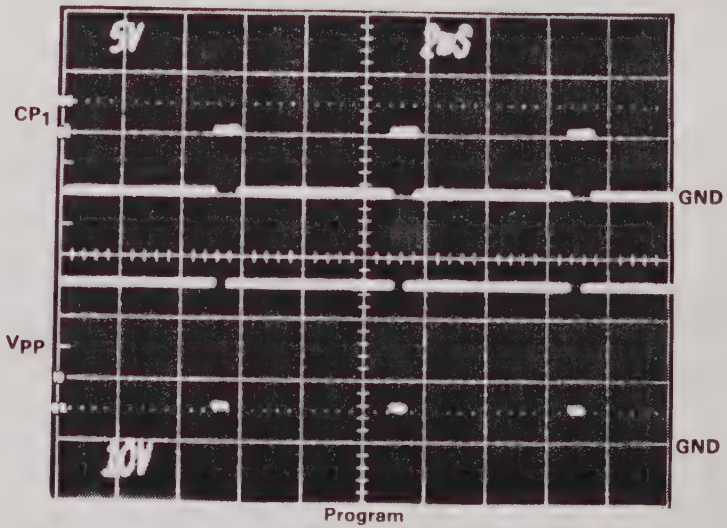
TIMING DIAGRAM

FAMILY CODES 27, 28

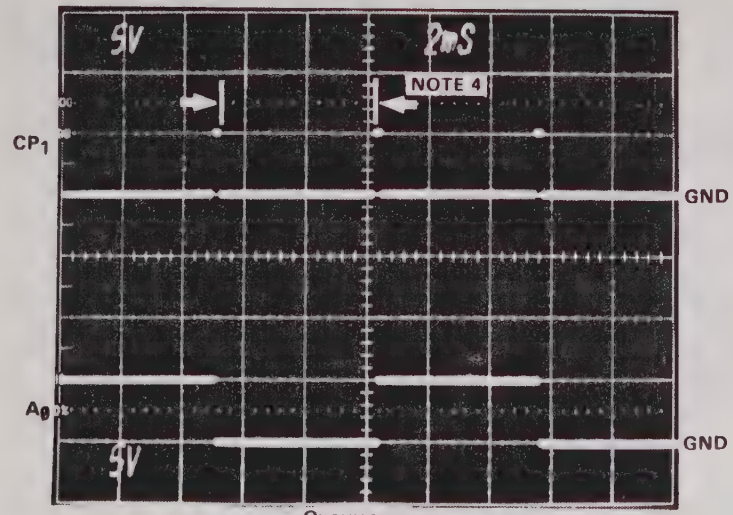
DATA I/O



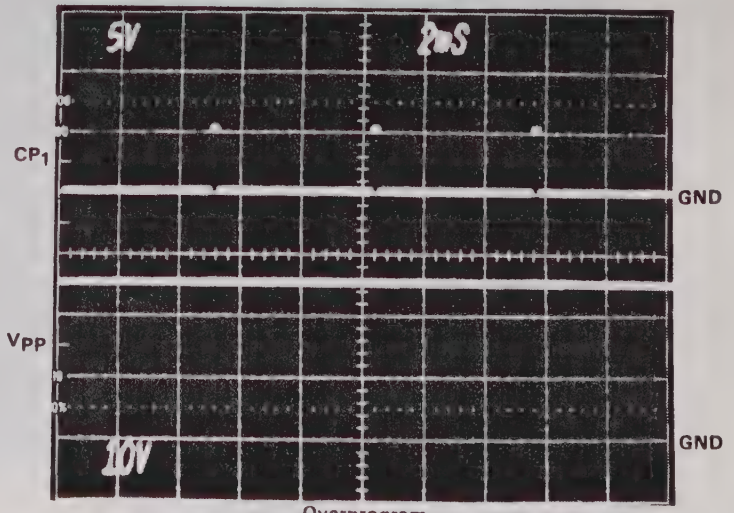
Program
1



Program
2



Overprogram
3



Overprogram
4

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IL}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	4.8		5.2	msec	
	Pulse Count		5			Per byte
	Overprogram t_{pw}	4.8		26	msec	See note 4
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}				V	
ERASE	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IH}.*
4. *The length of the overprogram pulse will vary proportionally with the worst case number of pulses applied to any one byte. (This pulse is then applied to all bytes.)*

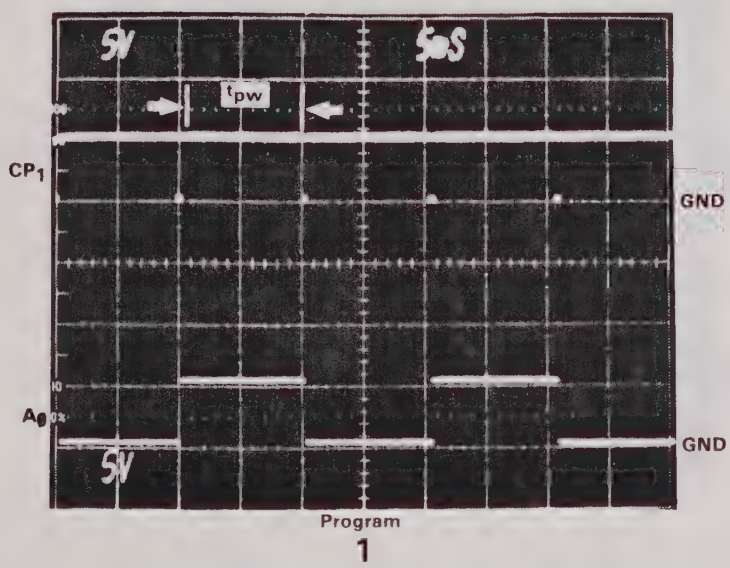
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DY	5/6/83

TIMING DIAGRAM

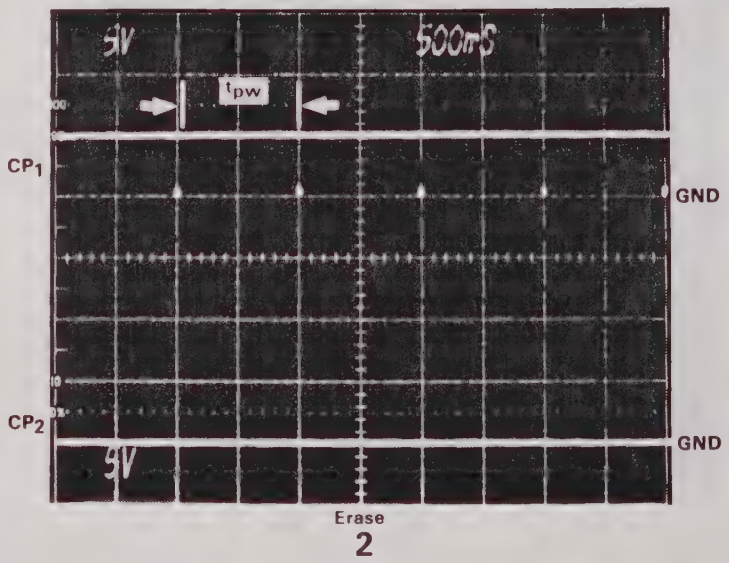
FAMILY CODES 31, 32

DATA I/O



Program

1



Erase

2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	9.6		10.4	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	24.0	25.0	26.0	V	
	t_{pw}	0.96		1.04	sec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IL}		V	See note 2
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. V_{IH} = *minimum 2.2 VDC.*
   = *maximum* V_{CC} + *0.5 VDC.*
   V_{IL} = *minimum −0.1 VDC.*
   = *maximum 0.8 VDC.*
3. *Pulsed from* V_{IL}.

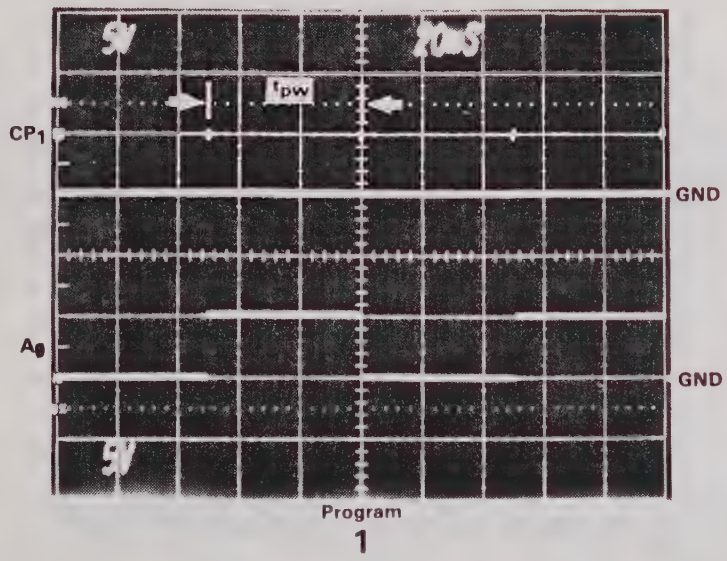
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DG	5/15/85

TIMING DIAGRAM

FAMILY CODES 33, 34

DATA I/O


5V
20μS
tpw
CP1
GND
A0
GND
5V
Program
1

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.5	21.0	21.5	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	48		52	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP ERASE	V_{CC}				V	
	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	
	t_f (V_{PP})				µsec	
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IH}.*

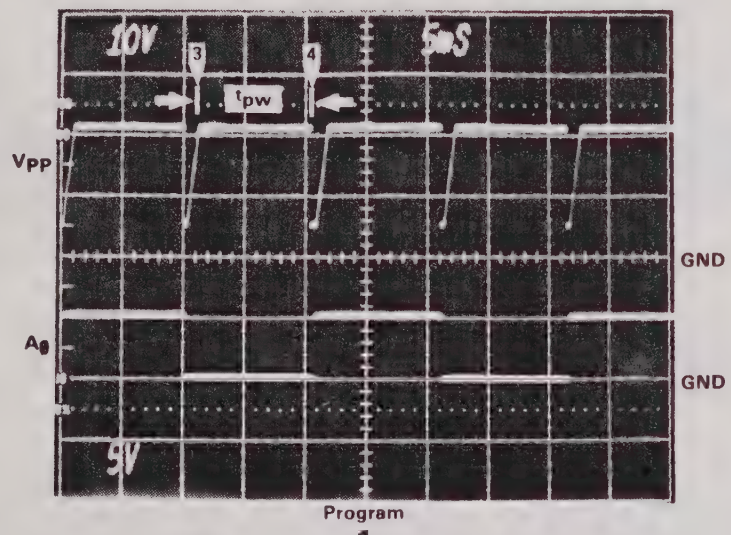
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DM	5/1/85

TIMING DIAGRAM

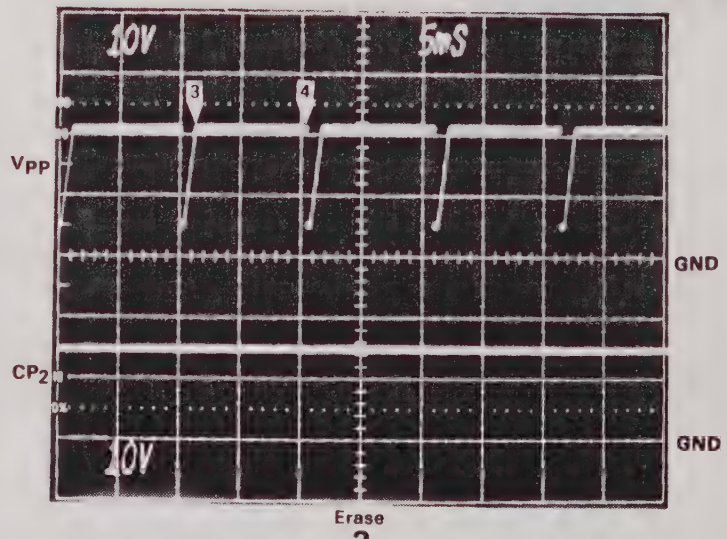
FAMILY CODES 35, 36

DATA I/O



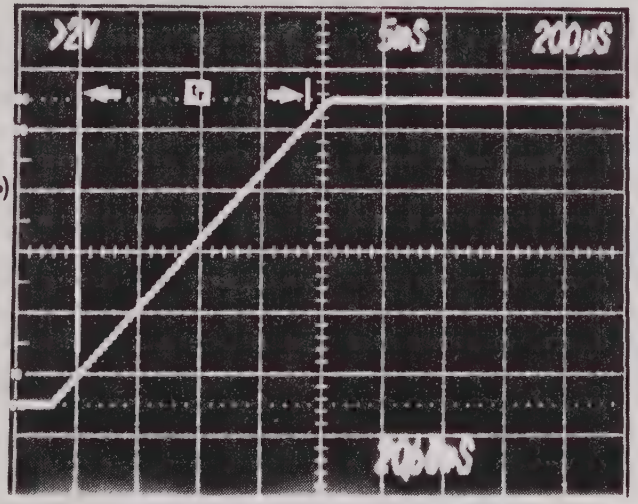
Program

1

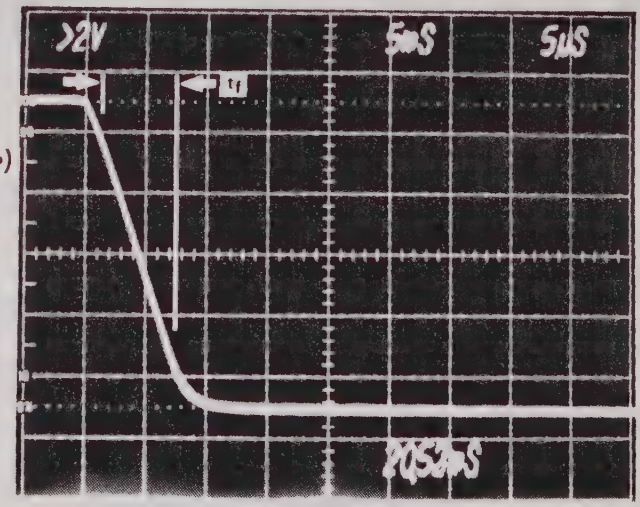


Erase

2



3



4

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.0	21.0	22.0	V	See note 4
	t_r (V_{PP})	710		730	µsec	10% - 90%
	t_f (V_{PP})			100	µsec	10% - 90%
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	8.8		9.6	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	20.0	21.0	22.0	V	See note 4
	t_{pw}	8.8		9.6	msec	
	t_r (V_{PP})	710		730	µsec	10% - 90%
	t_f (V_{PP})			100	µsec	10% - 90%
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IHH}		V	See note 3
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. V_{IH} = *minimum 2.2 VDC.*
   = *maximum* V_{CC} + *0.5 VDC.*
   V_{IL} = *minimum −0.1 VDC.*
   = *maximum 0.8 VDC.*
3. V_{IHH} = *minimum 14.0 VDC.*
   = *nominal 14.5 VDC.*
   = *maximum 15.0 VDC.*
4. *Pulsed from* V_{CC}.

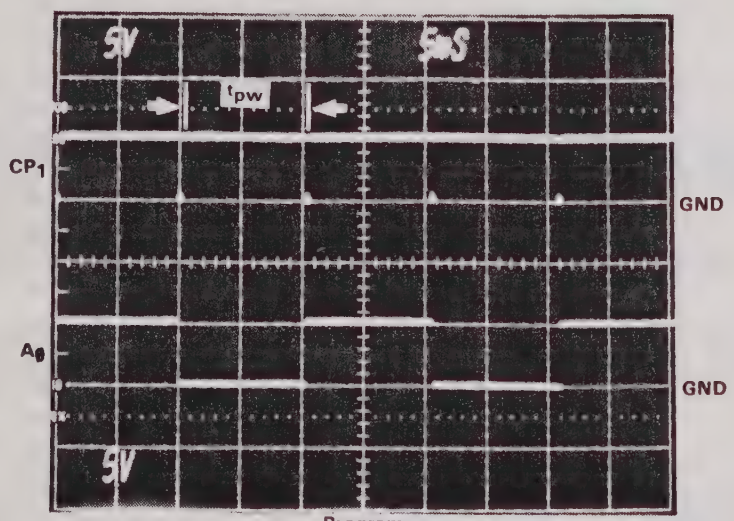
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release		

TIMING DIAGRAM

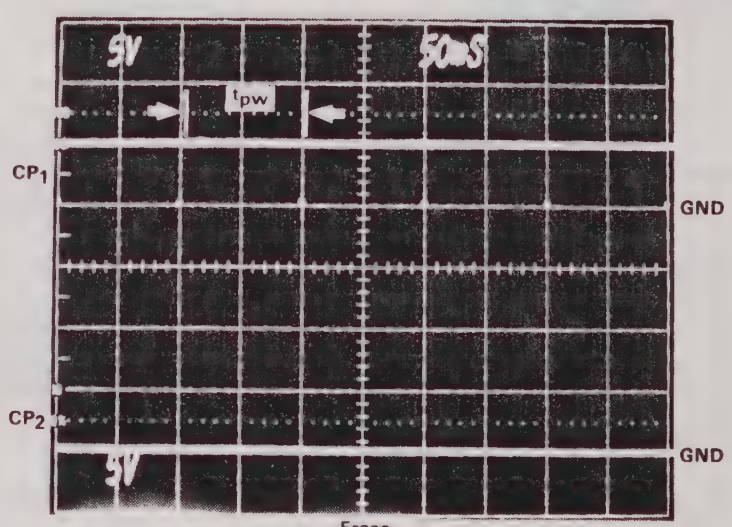
FAMILY CODES 37, 38

DATA I/O



Program

1



Erase

2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	9.6		10.4	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	24.0	25.0	26.0	V	
	t_{pw}	96		104	msec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IL}		V	See note 2
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IL}.*

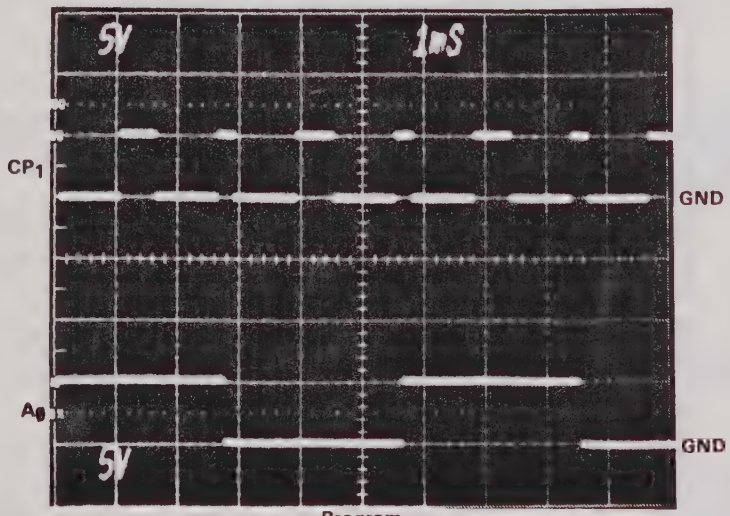
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DM	5/18/83

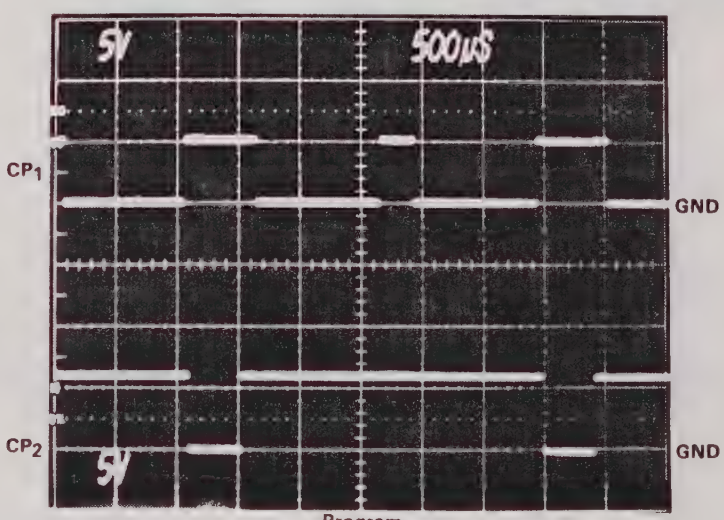
TIMING DIAGRAM

FAMILY CODES 43, 44

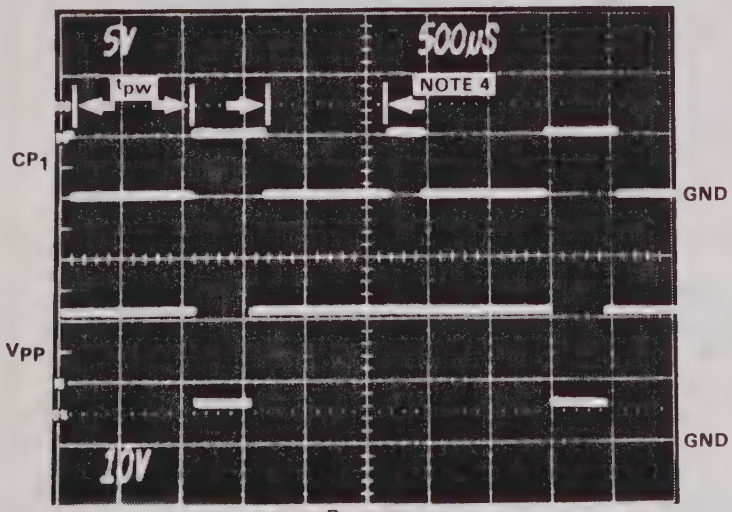
DATA I/O


5V
1mS
CP1
GND
A0
GND
5V
Program

1


5V
500uS
CP1
GND
CP2
GND
5V
Program

2


5V
500uS
tpw
NOTE 4
CP1
GND
VPP
GND
10V
Program

3

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	5.75	6.0	6.25	V	
	V_{PP}	20.5	21.0	21.5	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	0.95		1.05	msec	
	Pulse Count	1		20		Per byte
	Overprogram t_{pw}	0.95		21	msec	See note 4
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP ERASE	V_{CC}				V	
	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	
	t_f (V_{PP})				µsec	
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC. = maximum V_{CC} + 0.5 VDC.*
   V_{IL} = minimum −0.1 VDC. = maximum 0.8 VDC.
3. *Pulsed from V_{IH}.*
4. *The length of the overprogram pulse will vary proportionally with the number of pulses applied (determined and applied on a per byte basis).*

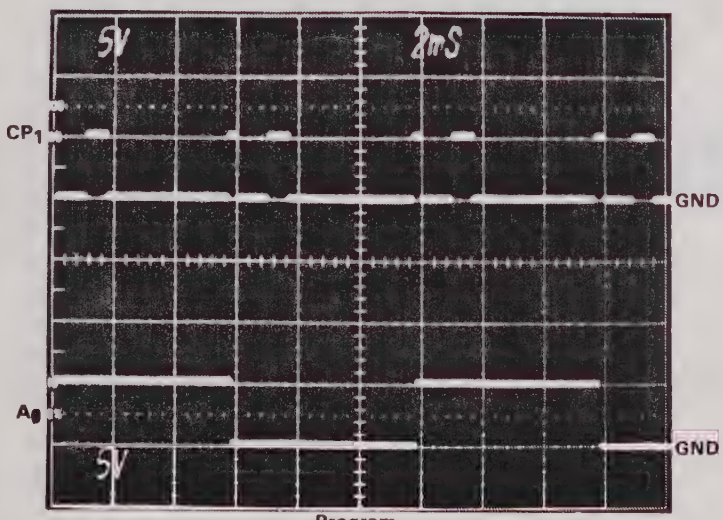
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DG	5/16/84

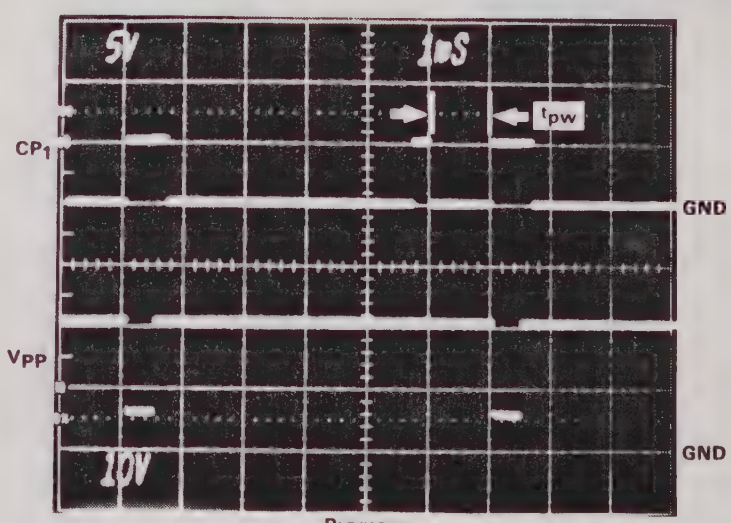
TIMING DIAGRAM

FAMILY CODES 45, 46

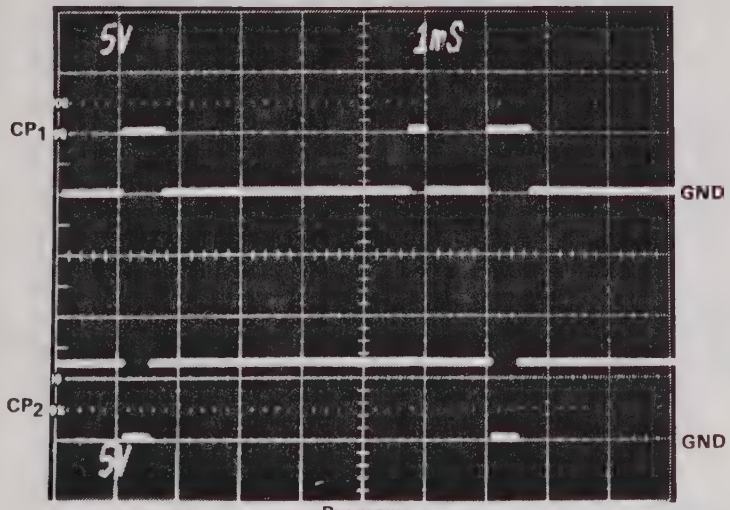
DATA I/O



Program
1



Program
2



Program
3

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	5.75	6.0	6.25	V	
	V_{PP}	20.5	21.0	21 5	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	0.95		1.05	msec	
	Pulse Count	1		15		Per byte
	Overprogram t_{pw}	3.8		63	msec	See note 4
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}				V	
ERASE	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	
	t_f (V_{PP})				µsec	
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IH}.*
4. *The length of the overprogram pulse will vary proportionally with the number of pulses applied (determined and applied on a per byte basis).*

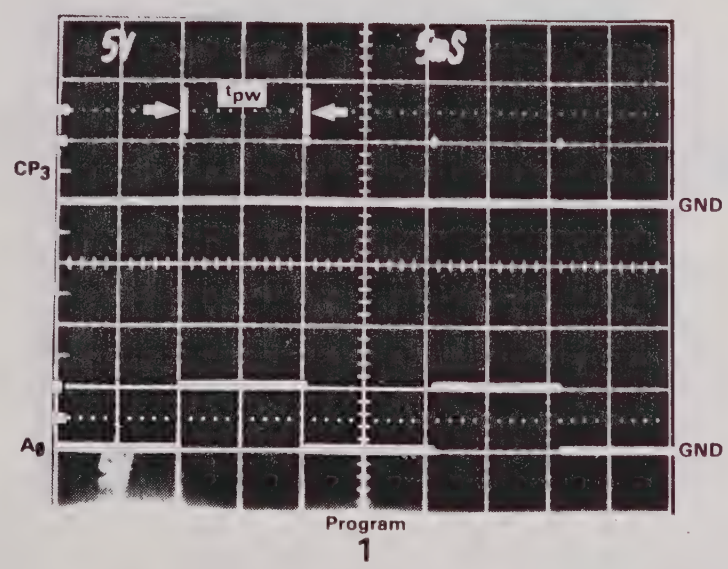
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DG	5/22/??

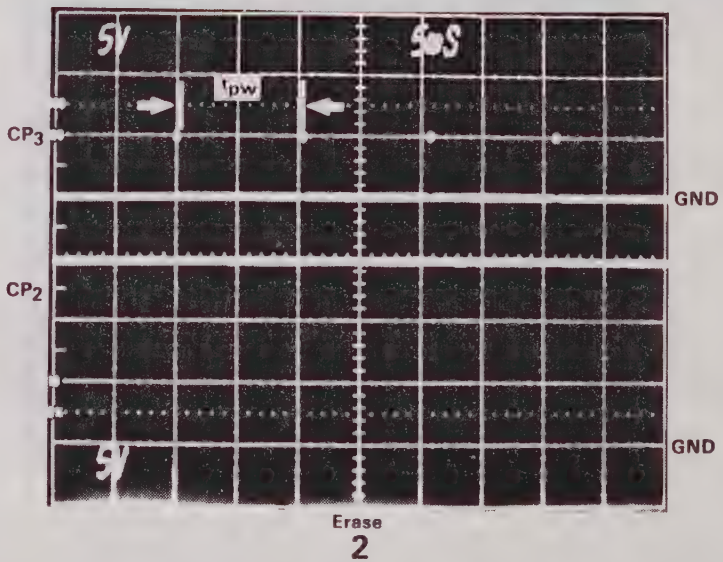
TIMING DIAGRAM

FAMILY CODES 79, 7A

DATA I/O



Program
1



Erase
2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.0	21.0	22.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See notes 2 & 3
	t_{pw}	9.6		10.4	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	20.0	21.0	22.0	V	
	t_{pw}	9.6		10.4	msec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IHH}		V	See note 4
	CP_3		V_{IL}		V	See note 2 & 3

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. V_{IH} *= minimum 2.2 VDC.*
   = maximum V_{CC} *+ 0.5 VDC.*
   V_{IL} *= minimum −0.1 VDC.*
   = maximum 0.8 VDC.
3. *Pulsed from* V_{IH}.
4. V_{IHH} *= minimum 14.0 VDC.*
   = nominal 14.5 VDC.
   = maximum 15.0 VDC.

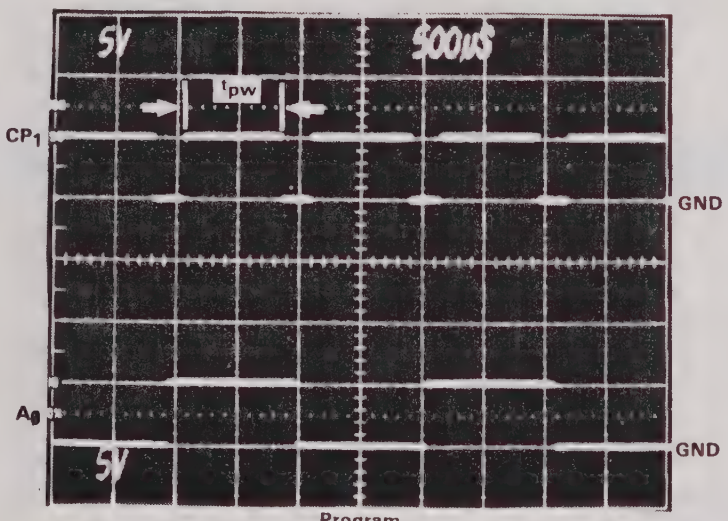
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DG	5/12/-

TIMING DIAGRAM

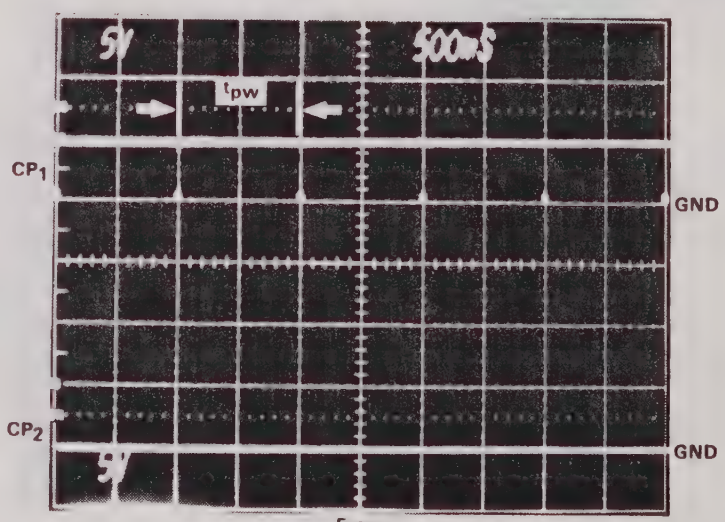
FAMILY CODES 81, 82

DATA I/O



Program

1



Erase

2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	24.0	25.0	26.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	0.8		1.0	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	24.0	25.0	26.0	V	
	t_{pw}	.96		1.04	sec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IH}		V	See notes 2 & 3
	CP_2		V_{IL}		V	See note 2
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IL}.*

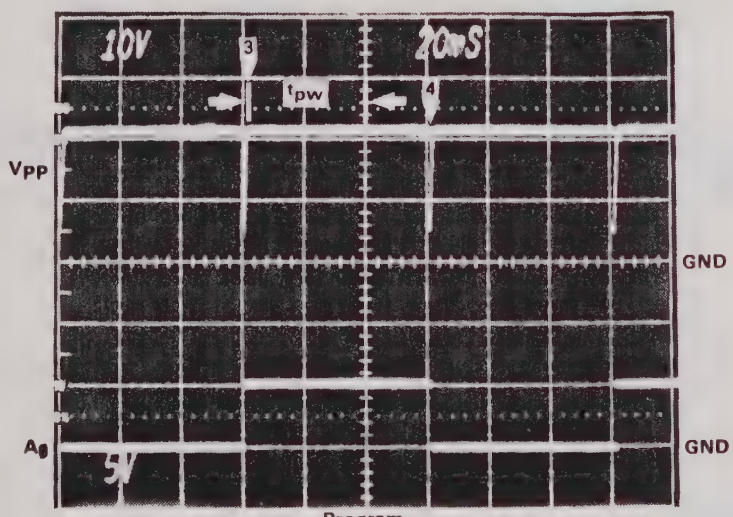
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DCJ	5/6/83

TIMING DIAGRAM

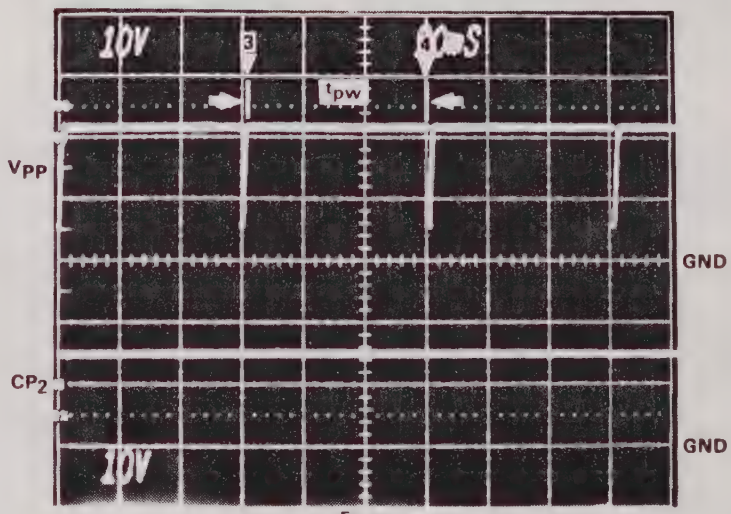
FAMILY CODES 83, 84

DATA I/O



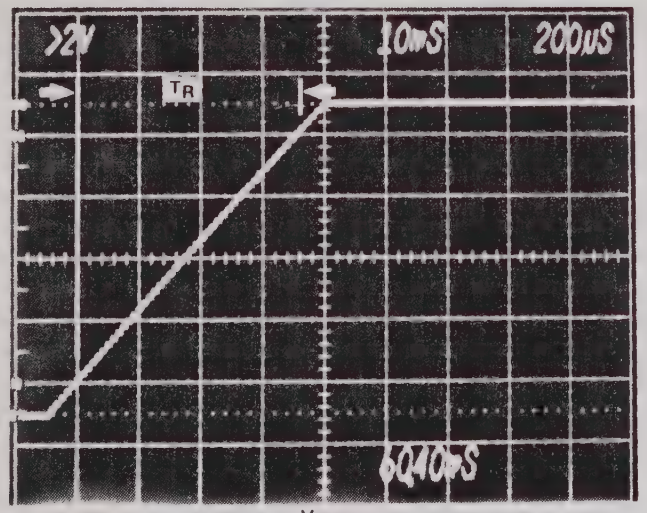
Program

1



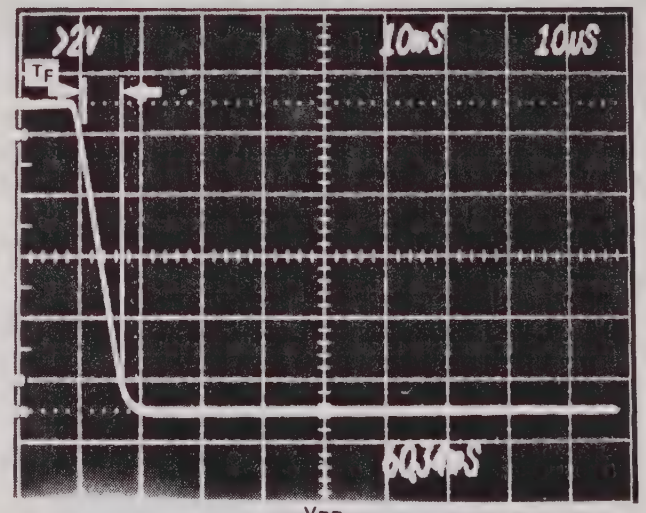
Erase

2



VPP

3



VPP

4

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.0	21.0	22.0	V	See note 3
	t_r (V_{PP})	710		730	µsec	10% - 90%
	t_f (V_{PP})			100	µsec	10% - 90%
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	57		63	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP ERASE	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.0	21.0	22.0	V	See note 3
	t_{pw}	57		63	msec	
	t_r (V_{PP})	710		730	µsec	10% - 90%
	t_f (V_{PP})			100	µsec	10% - 90%
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IHH}		V	See note 4
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{CC}.*
4. *V_{IHH} = minimum 14.0 VDC.*
   = nominal 14.5 VDC.
   = maximum 15.0 VDC.

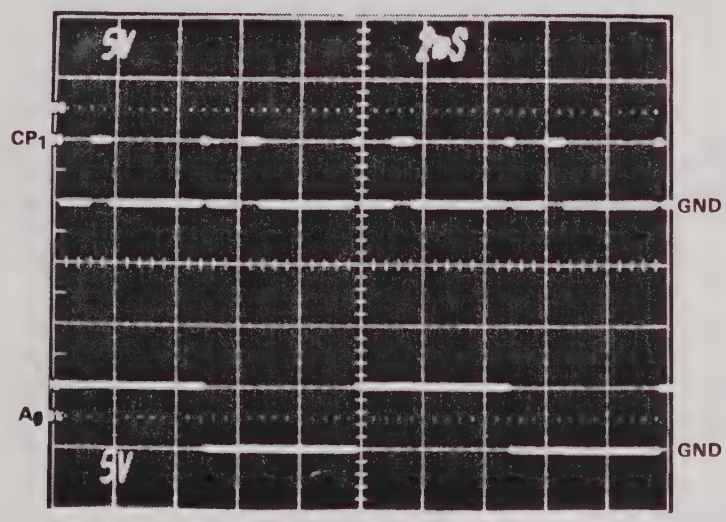
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release		

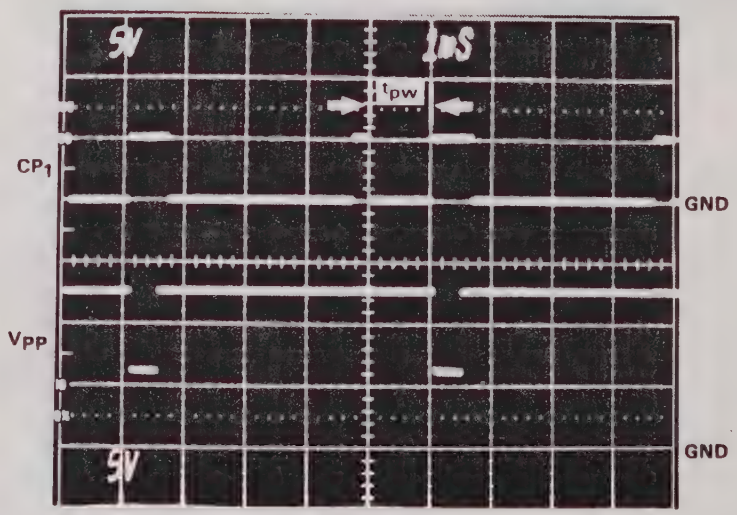
TIMING DIAGRAM

FAMILY CODES 85, 86

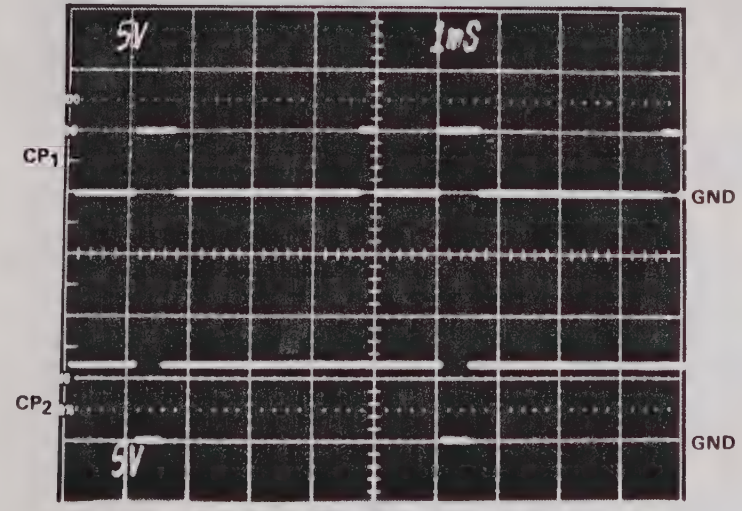
DATA I/O


5V
1mS
CP1
GND
A0
GND
5V

1


5V
1mS
tpw
CP1
GND
Vpp
GND
5V

2


5V
1mS
CP1
GND
CP2
GND
5V

3

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	5.75	6.0	6.25	V	
	V_{PP}	12.2	12.5	12.8	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	0.95		1.05	msec	
	Pulse Count	1		25		Per byte
	Overprogram t_{pw}	2.85		78.75	msec	See note 4
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}				V	
ERASE	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	
	t_f (V_{PP})				µsec	
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IH}.*
4. *The length of the overprogram pulse will vary proportionally with the number of pulses applied (determined and applied on a per byte basis).*

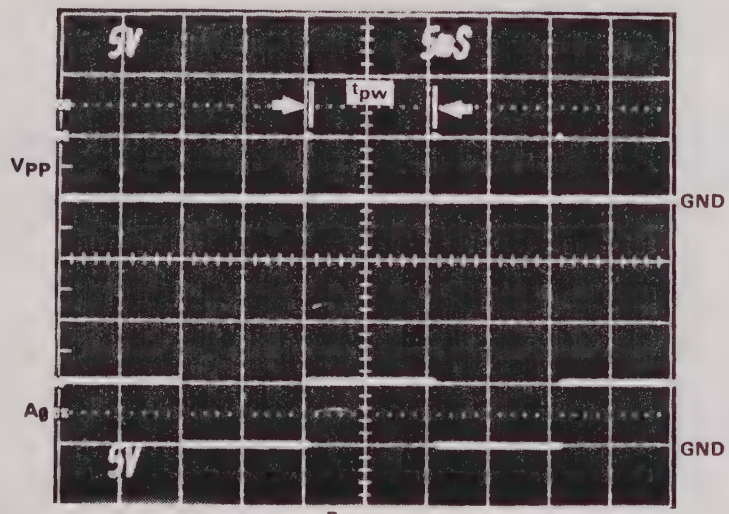
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DG	1/19/95

TIMING DIAGRAM

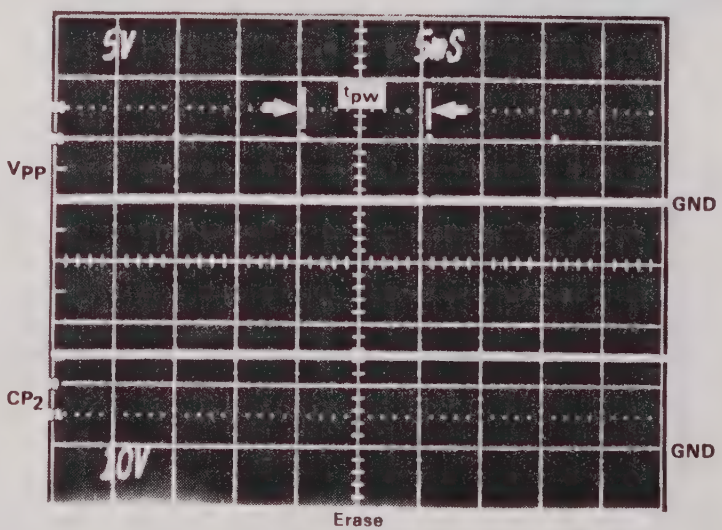
FAMILY CODES 93, 94

DATA I/O



Program

1



Erase

2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	-0.1	0	0.8	V	See note 3
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	9.6		10.4	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	-0.1	0	0.8	V	See note 3
	t_{pw}	9.6		10.4	msec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IHH}		V	See note 4
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{CC}.*
4. *V_{IHH} = minimum 14.0 VDC.*
   = nominal 14.5 VDC.
   = maximum 15.0 VDC.

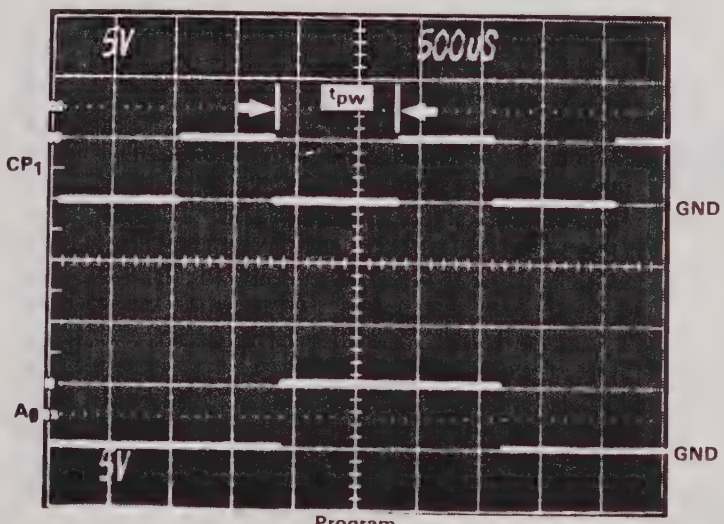
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	dy	5/1/83

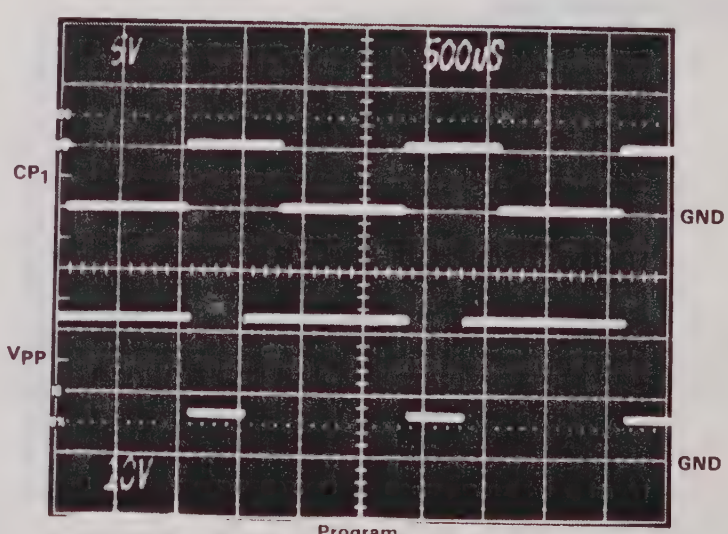
TIMING DIAGRAM

FAMILY CODES A5, A6

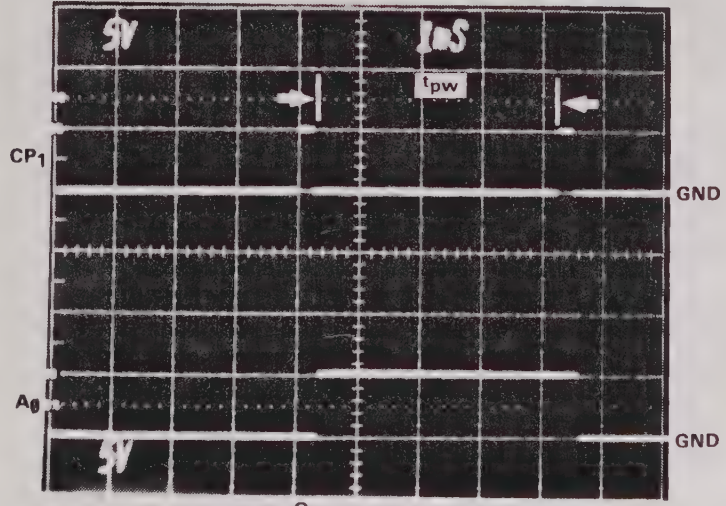
DATA I/O



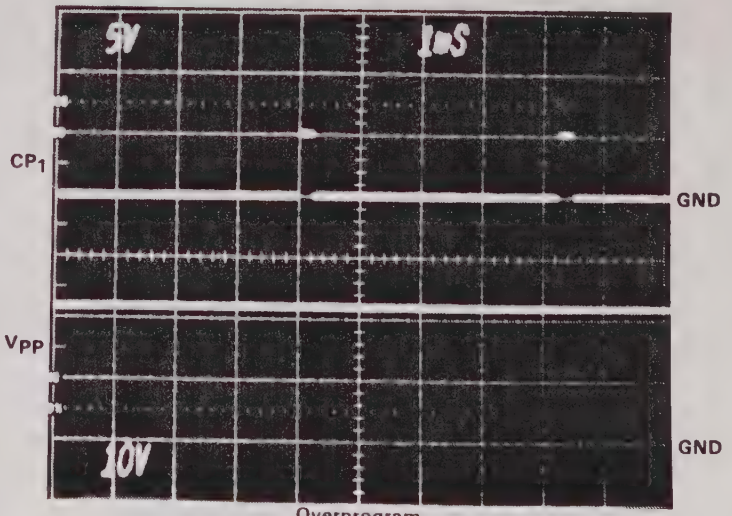
Program
1



Program
2



Overprogram
3



Overprogram
4

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	5.75	6.0	6.25	V	
	V_{PP}	21.0	21.5	22.0	V	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	0.95		1.05	msec	
	Pulse Count	1		40		Per byte
	Overprogram t_{pw}	3.8		4.2	msec	
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.5	5.6	5.7	V	2nd pass
CHIP ERASE	V_{CC}				V	
	V_{PP}				V	
	t_{pw}				sec	
	t_r (V_{PP})				µsec	
	t_f (V_{PP})				µsec	
	CP_1				V	
	CP_2				V	
	CP_3				V	

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum − 0.1 VDC.
   = maximum 0.8 VDC.
3. *Pulsed from V_{IH}.*

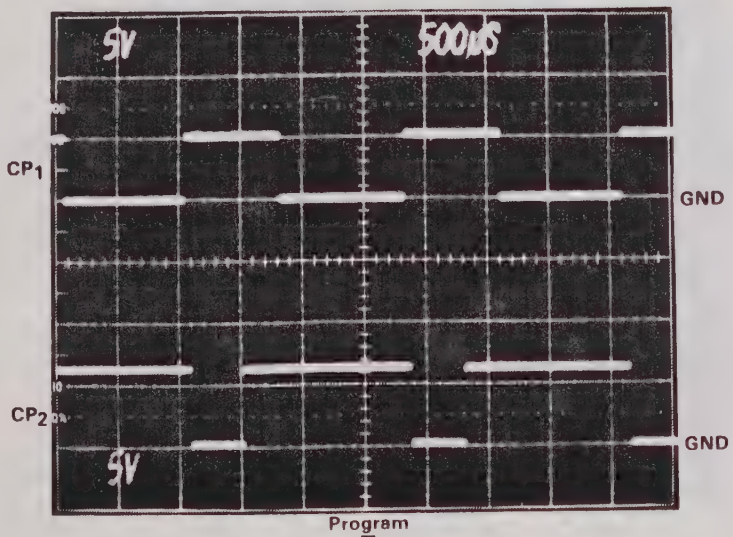
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	BCJ	5/12/93

TIMING DIAGRAM

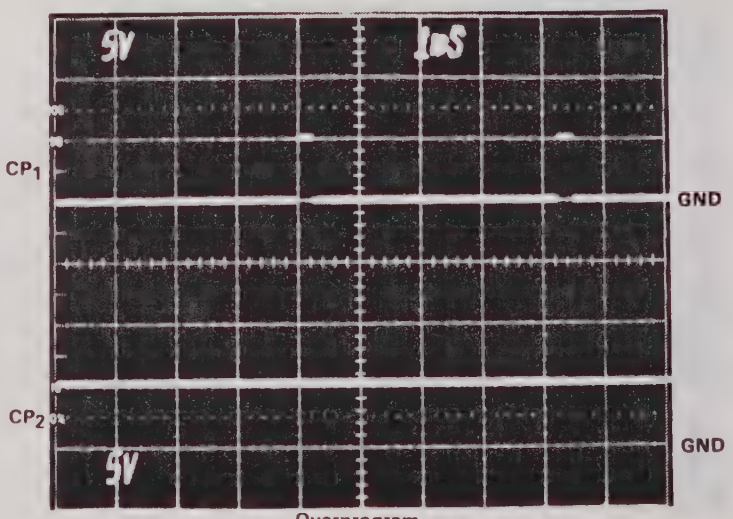
FAMILY CODES AF, B0

DATA I/O



Program

5



Overprogram

6

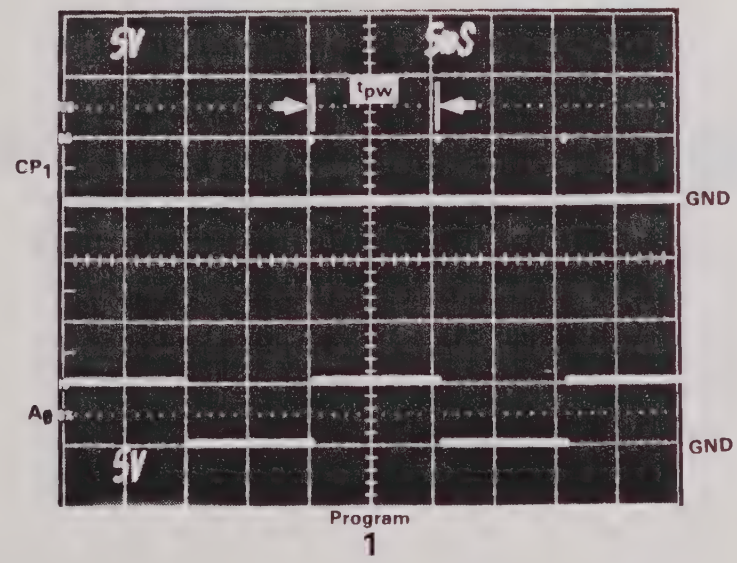
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	BMJ	5/1/84

TIMING DIAGRAM

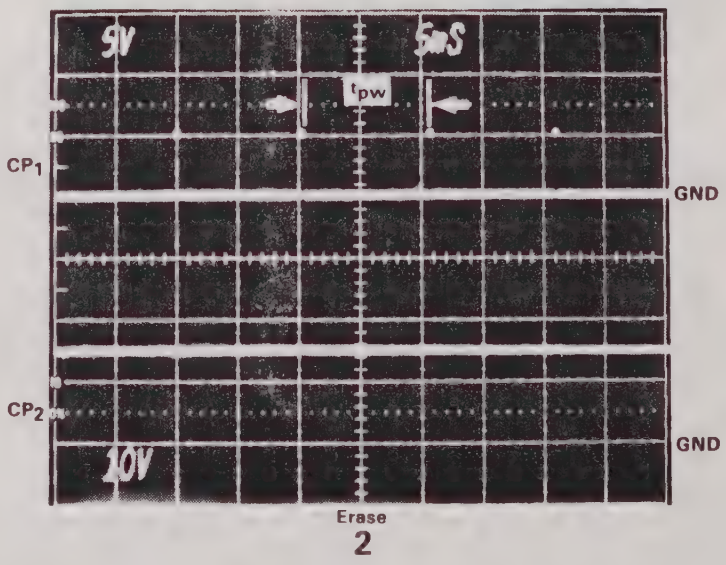
FAMILY CODES AF, B0

DATA I/O



Program

1



Erase

2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	20.0	21.0	22.0	V	NA
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	9.6		10.4	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	20.0	21.0	22.0	V	
	t_{pw}	9.6		10.4	msec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See notes 2 & 3
	CP_2		V_{IHH}		V	See note 4
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. V_{IH} = *minimum 2.2 VDC.*
   = *maximum* V_{CC} + *0.5 VDC.*
   V_{IL} = *minimum −0.1 VDC.*
   = *maximum 0.8 VDC*
3. *Pulsed from* V_{IH}.
4. V_{IHH} = *minimum 14.0 VDC.*
   = *nominal 14.5 VDC.*
   = *maximum 15.0 VDC.*

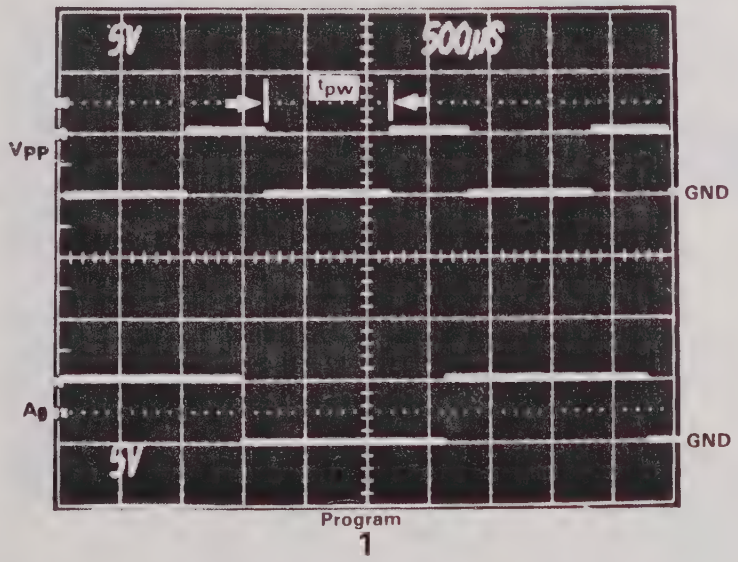
REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	DM	5/29/85

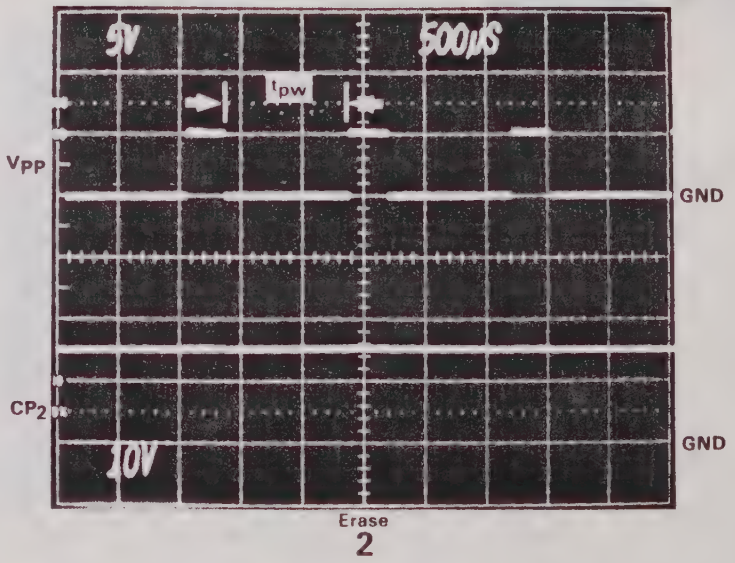
TIMING DIAGRAM

FAMILY CODES B3, B4

DATA I/O



Program
1



Erase
2

FAMILY CHARACTERISTICS

	VARIABLE	MIN	NOM	MAX	UNIT	COMMENTS
PROGRAM	V_{CC}	4.75	5.0	5.25	V	
	V_{PP}	-0.1	0	0.8	V	See note 3
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IH}		V	See note 2
	CP_3		V_{IL}		V	See note 2
	t_{pw}	0.96		1.04	msec	
	Pulse Count		1			Per byte
	Overprogram t_{pw}				msec	NA
VERIFY	V_{CCL}	4.7	4.8	4.9	V	1st pass
	V_{CCH}	5.1	5.2	5.3	V	2nd pass
CHIP	V_{CC}	4.75	5.0	5.25	V	
ERASE	V_{PP}	-0.1	0	0.8	V	See note 3
	t_{pw}	0.96		1.04	msec	
	t_r (V_{PP})				µsec	NA
	t_f (V_{PP})				µsec	NA
	CP_1		V_{IL}		V	See note 2
	CP_2		V_{IHH}		V	See note 4
	CP_3		V_{IL}		V	See note 2

NOTES

1. *Programming waveform photographs taken using calibration step 32, pinout 33. Erase waveform photographs taken using calibration step 33, pinout 33.*
2. *V_{IH} = minimum 2.2 VDC.*
   = maximum V_{CC} + 0.5 VDC.
   V_{IL} = minimum −0.1 VDC.
   = maximum 0.8 VDC
3. *Pulsed from V_{CC}.*
4. *V_{IHH} = minimum 14.0 VDC.*
   = nominal 14.5 VDC.
   = maximum 15.0 VDC.

REVISIONS

LTR	DESCRIPTION	P.E.	DATE
A	Release	AY	5/13/82

TIMING DIAGRAM

FAMILY CODES B9, BA

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SINGAPORE

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SOUTH & CENTRAL AMERICA

Dexter Computer Products, Inc.
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Suite N
Torrence, CA 90503
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Telex 182360 DXTR TRNC

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THAILAND

Dynamic Supply Engineering R.O.P.
12 Soi Pasara 1, Sukhumvit 63
Bangkok-11, Thailand
Tel. - 3914434, 39228532
Telex 82455 DYNASUP TH

Warranty 90 Days

Data I/O warrants that all equipment sold pursuant to any resultant agreement shall be free from defects in material or workmanship at the time of delivery. Such warranty shall extend for 90 days. Buyer must provide notice to Data I/O within this prescribed warranty period of any defect, if the defect is not the result of improper usage, service, maintenance or installation and equipment has not been otherwise damaged or modified after delivery, Data I/O shall either replace or repair the defective part or parts of equipment or replace the equipment or refund the purchase price at Data I/O's option after return of such equipment by buyer to Data I/O. Shipment to and from Data I/O's facility shall be borne on account of buyer.

(a) Consequential Damages — Data I/O shall not be liable for any incidental or consequential damages incurred as a result of any defect in any equipment sold hereunder, and Data I/O's liability is specifically limited to its obligation described herein to repair or replace a defective part or parts covered by this warranty.

(b) Exclusive Warranty — The warranty set forth herein is the only warranty, oral or written, made by Data I/O and is in lieu of and replaces all other warranties, expressed or implied, including the WARRANTY OF MERCHANTABILITY AND THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

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DATA I/O
Reader Comments
Applications Manager
10525 Willows Road N.E.
C-46
Redmond, WA 98052

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DATA I/O
Warranty/Registration
Service Manager
10525 Willows Road N.E.
C-46
Redmond, WA 98052

Reader Comments

The manual's completeness, accuracy, organization, usability, and reliability: _____

_____

Did you find errors in this manual? _____

How can this manual be improved? _____

_____

_____

Additional comments: _____

_____

Name _____ Title _____

Department _____ M/S _____

Company _____

Address _____

City _____ State _____ Zip _____

Phone ( ) _____

Manual or Part No. _____

Warranty/Registration

Please return this card to Data I/O within five days

Did the packaging of this equipment exhibit any outward signs of physical damage? . ☐ YES ☐ NO

Did this equipment arrive intact, without loose parts or cable damage? ..... ☐ YES ☐ NO

Did the equipment operate on power-up? ..... ☐ YES ☐ NO

Did you attain adequate system performance? ..... ☐ YES ☐ NO

Were any electrical adjustments required? ..... ☐ YES ☐ NO

If you required assistance, was a local Data I/O representative contacted? ..... ☐ YES ☐ NO

Comments: _____

_____

Name _____ Title _____

Department _____ M/S _____

Company _____

Address _____

City _____ State _____ Zip _____

Phone ( ) _____

Model or Description _____ Serial or Part No. _____

Date Received _____

DATA I/O

10525 Willows Road N.E./C-46
Redmond, WA 98052
(206) 881-6444 Telex 15-2167